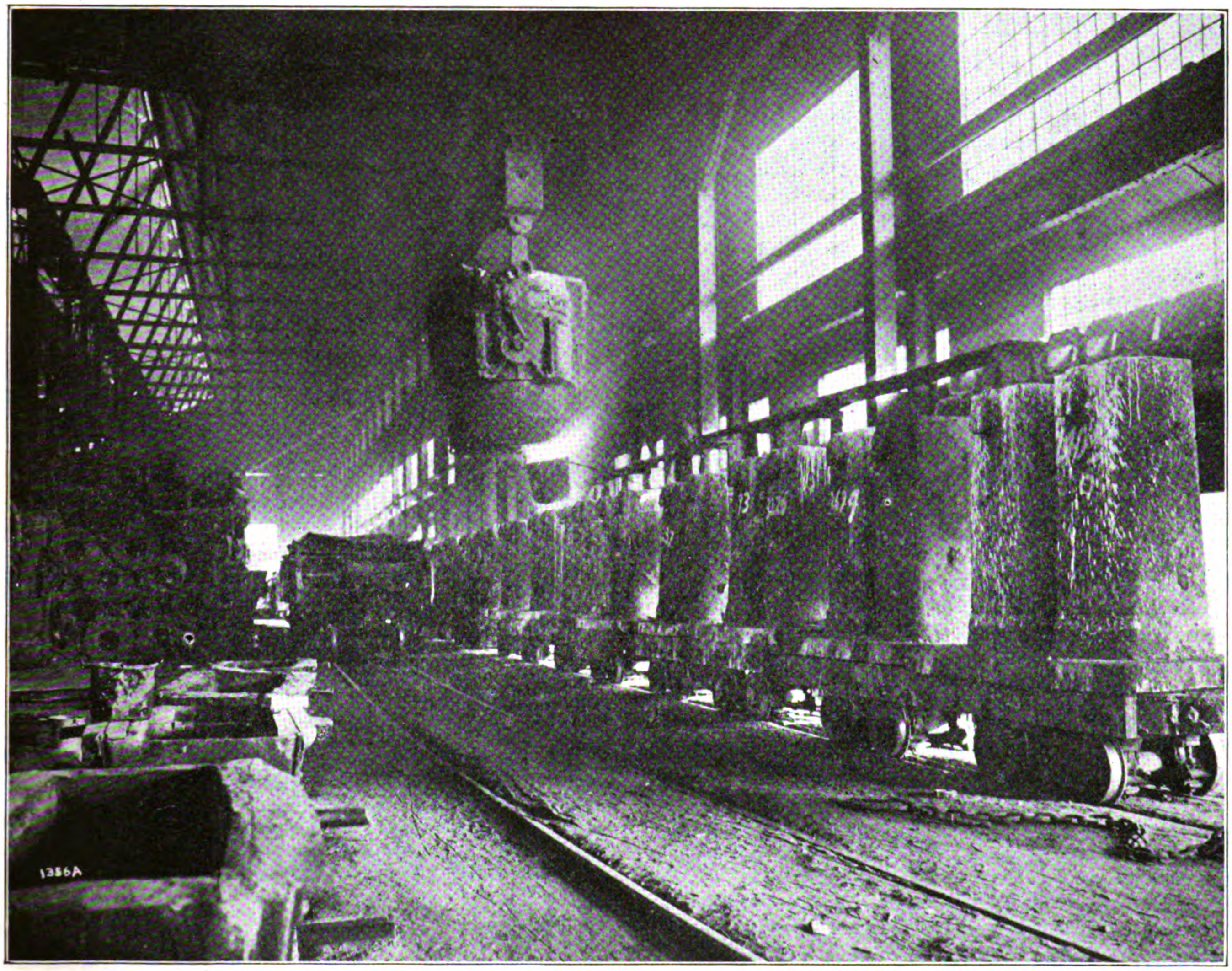
The Blast Furnace and Steel Plant

Vol. XI PITTSBURGH, PA., JULY, 1923 No. 7

Pouring Steel Ingots



No. 3 Open Hearth.

Reference to pages 304-310 of the June issue of this magazine will show the following description of power generation and distribution units in operation at Bethlehem:

Lehigh Division—Direct Current Station.
Saucon Division—Direct Current Station.
Alternating Current Power Station.
Operation of the Power System.
Motor Generator Sets.
Transformers.
Distributing System.

Part II, on the following pages, will visualize the many operations between the receipt of the ore and raw materials and the final shipment of the finished forms.

A Great Diversified Manufacturing Plant

Where Steel Is Made in the Usual Heavy Tonnage Shapes, But Also Enormous Manufacturing Activities Produce an Endless Variety of Unusual Finished Products

By D. M. PETTY* and A. J. STANDING†

PART II

ORE is brought into the plant in gondola cars which are dumped by a two car Hoover & Mason Car Dumper into bins. From the bins stock is drawn for current consumption, in the furnace, into Hoover & Mason transfer cars which move it from the car dumper bins to the blast furnace bins, an average distance of approximately one-half mile. These cars are equipped with four 35 hp. d.c. motors and take their power from an overhead trolley wire, the tracks serving as a ground return. This power is taken from a separate motor generator set in the d.c. power station. Incoming ore in excess of daily requirements is transferred from the car dumper bins into a side dump distributing car from which it is dumped into a concrete trough, from where the ore bridges place it on the stock piles. Ore is also taken from stock and placed directly in the transfer cars by the ore bridges. The bulk of the limestone for the blast furnace department is brought into the plant over a Telferage System from the quarry located on the north side of the Lehigh River. The Telferage system drops the stone into storage bins which stand above the transfer car tracks and from which the cars are loaded. Limestone from other quarries is handled in the same manner as ore.

A visit to Bethlehem leaves a different impression than is received at any other plant in America.

As a steel producing unit it differs in no way from many other great units which have been described, but as a complete manufacturing establishment it is most impressive.

The analysis of its power facilities, described in June, carries with it the thought of conservation of power resources, with an application of by-product recoveries based on far-sighted future tendencies.

The manufacturing departments reflect in no less degree a completeness of detail which combine to make this plant a most unique symbol of preparedness. Mechanical equipment supercedes the necessities of hand labor. Wherever an automatic control can be made operative it will be found in service. Safety for human life and limb is not a mere dogma—it is an applied fact. The total result is a working atmosphere of human contentment, co-ordinated activity, and intense loyalty to a finely balanced organization.

Coke is dumped directly into the blast furnace bins from hopper bottom coke cars coming directly from the by-product coke plant located approximately three miles from the blast furnace department. From the blast furnace bins, coke, stone, ore, etc., is discharged over roller gates into scale cars, which dump directly into the skip hoist bucket. The skip hoists are of the balanced type and were built by the Otis Elevator Company; motors are of the d.c. type and rated at 200 hp.

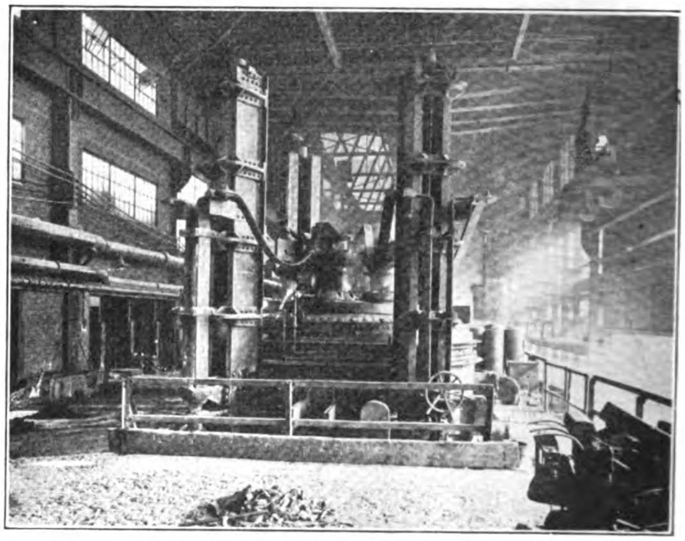
The blowing engine equipment consists of 11 42x60 and two 45x60 Bethehem gas engines and three cross-compound Southwark steam engines.

With seven furnaces in operation one steam blower is usually required; with less than seven furnaces the gas engine driven blowers are used exclusively.

A large portion of the pig iron is transferred directly to the hot metal mixers in the open hearth department. Some goes to the ingot mould foundry, and only a very small percentage is cast into pigs.

No. 1 Open Hearth.

No. 1 Open Hearth is the oldest of the four open hearth departments. It contains 11 furnaces: One 10-ton, one 20-ton, one 40-ton, and one 50-ton acid furnaces, one 25-ton, four 40-ton and two 50-ton basic furnaces.



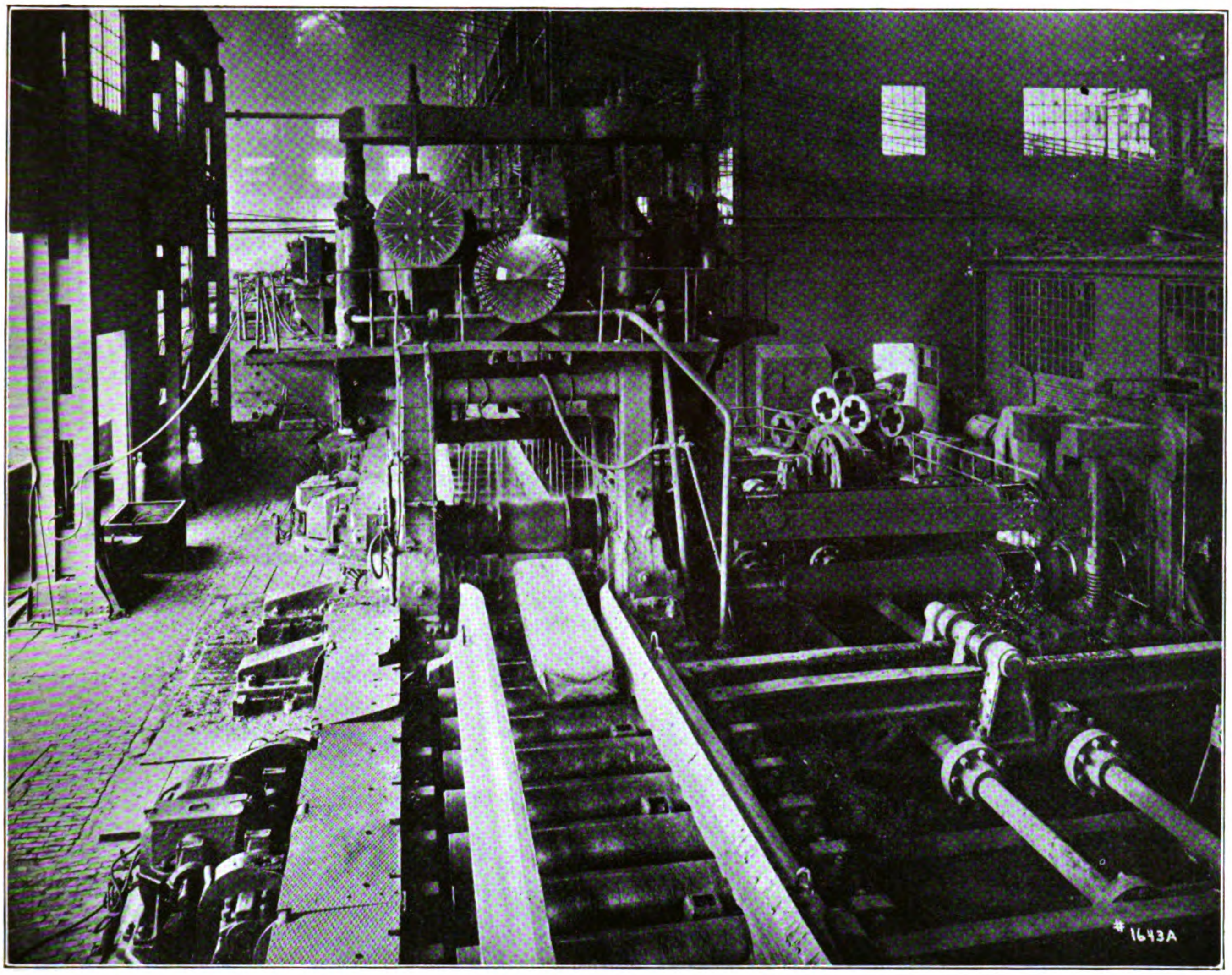
10-ton Girod electric furnace.

Seven of these furnaces are gas fired and four fired by oil or tar. A great variety of ingots are produced in this department, also a great variety of simple and alloyed steels for casting purposes. This department is equipped with a Whitworth fluid compression plant.

---

*Superintendent Electrical Department, Lehigh Division, Bethlehem Steel Company.

†Superintendent Electrical Department, Saucon Division, Bethlehem Steel Company.



35-in. blooming mill with soaking pits in background.

The following cranes serve the pit side of the furnaces:

Two 100-ton Alliance, one 100-ton Morgan and one 90-ton Alliance.

The charging equipment consists of two-high type Morgan charging machines.

The stock-yard is served by:

One 15-ton Pawling & Harnischfeger crane, one 20-ton Alliance crane and one 15-ton Alliance crane.

The ingot buggies are loaded on the ground level of the stockyard and hauled to the charging floor by means of steam locomotives.

Steel Foundry.

The steel foundry is adjacent to No. 1 open hearth and one bay is served by the crane runway which serves the pit side of the Open Hearth. Crane service in this bay is also furnished by the open hearth pit cranes for the heavy work; and there are in this and other bays eight smaller cranes. The steel foundry produces a large variety of steel castings. Very intricate, as well as heavy castings are made. The heaviest casting made to date weighed 375,000 lbs.

Forge Departments.

The forge equipment of the Bethlehem plant is very complete. There are hydraulic presses as follows:

One 14,000 ton, one 5,000 ton, one 2,500 ton, two 2,000 ton, one 1,000 ton, two 500 ton.

There are steam hammers as follows:

One 16,000 lb., one 12,000 lb., one 8,000 lb., one 6,000 lb., one 3,500 lb. and one 2,500 lb.

Suitable heating and annealing furnaces are installed.

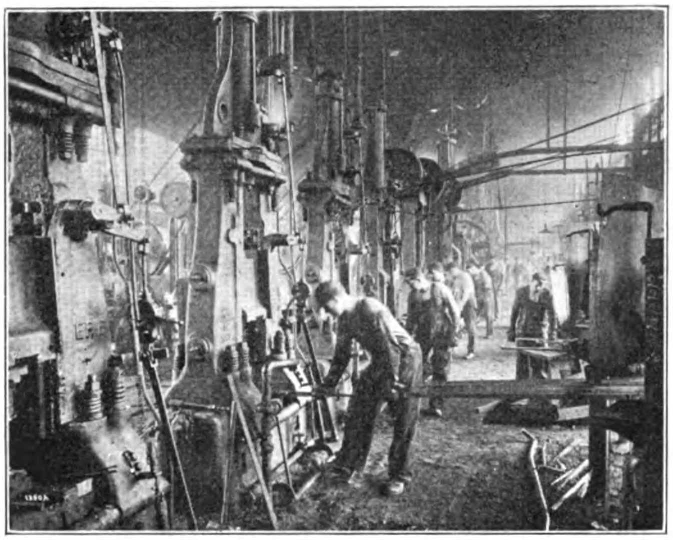
The 14,000 ton press was built to forge armor plate, and is now operating on large dimension round and hollow work, and on unusually heavy work. Hydraulic pressure for this press is furnished by 15,000 hp. steam engine. The other presses take their power from constant pressure hydraulic systems equipped with large accumulators and pumps. These pumps are all motor driven, the two largest pumps being driven by 750 hp., 6600 volt, 3 phase, slip ring motors. The secondary control of these motors is of the standard contactor type with cast iron resistors, the primary control, however, consists of a solenoid operated air break contactor, there being four breaks in each phase. These pumps are put on and taken off the line by means of a float switch operated from the accumulator, and under most severe conditions are compelled to stop and start as often as every one and one-half minutes. The pumps are all of standard Bethlehem design.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

The product of the Forge Departments covers the entire range from the heaviest forgings to the lightest. Types of the heavier forgings are crank-shafts for the largest engines built; large diameter rings and other hollow forgings; straight shafting, both hollow and solid forged; and reaction chambers. The smaller forgings cover a wide range of uses and include such products as forged steel balls, used in the cement grinding mills, and all kinds of small hammer work.

Drop Forge Department.

The drop forge hammer shop contains 33 hammers ranging in size from 8,000 to 400 lbs. The product of the department is made up of heavy and light automobile parts, permanent magnets for instruments, magnetoes, etc., both simple and alloyed steel.



Drop forge hammer shop.

In the die sinking shop electric reversing planers, as well as a large variety of portable electric tools, are used.

No. 2 Machine Shop.

This machine shop is equipped for the manufacture of guns up to 14 in., inclusive. Also to do every other kind of miscellaneous machine work; heavy rough machining, as well as finishing machining. Its product includes the largest machinery of all kinds, such as hydraulic presses, rolling mills, riveters, shears, Diesel oil engines, hydraulic turbines, etc.

This shop contains 280,150 sq. ft., of floor space and is equipped with 660 machine tools, a large percentage of which are motor driven; 26 cranes ranging from 5 to 75 tons serve various aisles of the shop.

Central Tool Department.

This department manufactures all tools and jigs for the Bethlehem Corporation plants; punches, dies, reamers, rivet sets, countersinks, chisel blanks, drills, milling cutters, shear knives, etc., as well as a large variety of smaller materials.

The equipment includes a full complement of forge fires, steam hammers and annealing furnaces; some of the last being electrically heated. One of the largest of these furnaces is rated at 150 kw. and is used for the treatment of steel rolls. The machine tool equipment includes 284 tools, practically all of which are motor driven.

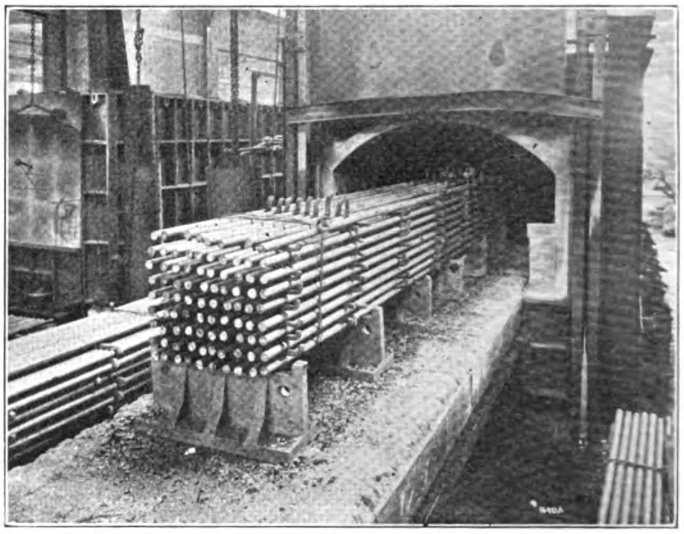
Tool Steel Department.

The tool steel department manufactures high grade tool steel, as well as other high grade alloy steels, such as special composition steels for electric welding, permanent magnet steel, drills, etc. Most of this steel is made in the electric furnaces. The furnace equipment consists of one 3-ton Heroult electric furnace, equipped with one General Electric three phase transformer of 1,000 kva. capacity, water cooled, 6600 volts primary. The current is controlled by a standard General Electric furnace control board. One 10-ton Girod furnace which is supplied with power from three 650 kva. water cooled Pittsburgh transformers, 6600 volts primary and 85/90/100 volts secondary. The current is controlled by a standard General Electric furnace control board. The steel is cast into ingots and either rolled into billets on a 16-in. mill or cogged on steam hammers. The hammer equipment consists of five hammers—one 4000 lbs., one 2500 lbs., one 1500 lbs,, one 1000 lbs. and 600 lbs.

A storehouse provides facilities for prompt shipments from this department.

Wheel Department.

This department manufactures a line of steel truck wheels which are made from rolled steel sections. The spokes and felloes are all in one piece, the felloe being electrically welded at one place on the rim. This wheel is at least twice as strong as any wooden wheel of the same weight. It has been tested at the Bureau of Standards. The report furnished us indicates that this wheel has a higher specific strength than any other wheel, previously tested by it.



Heating furnace for treating bars. No. 2 merchant mills.

No. 6 Machine Shop.

This department builds gas engines, large hydraulic pumps, bending rolls and other heavy machinery. It contains 69,000 sq. ft., of floor space and has 210 machine tools. Erecting floor is served by two 75-ton cranes and the main machine aisle is served by a 50-ton crane; the other aisles being served by a full complement of appropriate cranes. All machine tools are motor driven. An electro-plating equipment enables this department to furnish complete equipment for finished machines.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Iron Foundry.

This department manufactures a complete line of iron castings, including gas engine bed plates, large retorts, and is now engaged in the manufacture of the tunnel segments for the Jersey City-New York City vehicular tunnel. Its melting equipment consists of seven cupolas:

Two 84-in., two 60-in., one 52-in., one 42-in. and one 28-in.

In connection with this department is a 70-ft. x 300-ft. building for cleaning castings and a 70-ft. x 300-ft. stockyard. Segments are machined in the cleaning building on two rotary planers designed and built in the Bethlehem plant. The side planing machines are driven by two 125 hp., a.c., 220 volt motors. The end milling machine by one 125 hp., 220 volt induction motor. These motors are controlled by Electric Controller & Manufacturing Company automatic compensators, and so interlocked with the feed screw drive that it is impossible to wreck the machine by forcing the cutting tools into the work, unless the main drive motors are running..

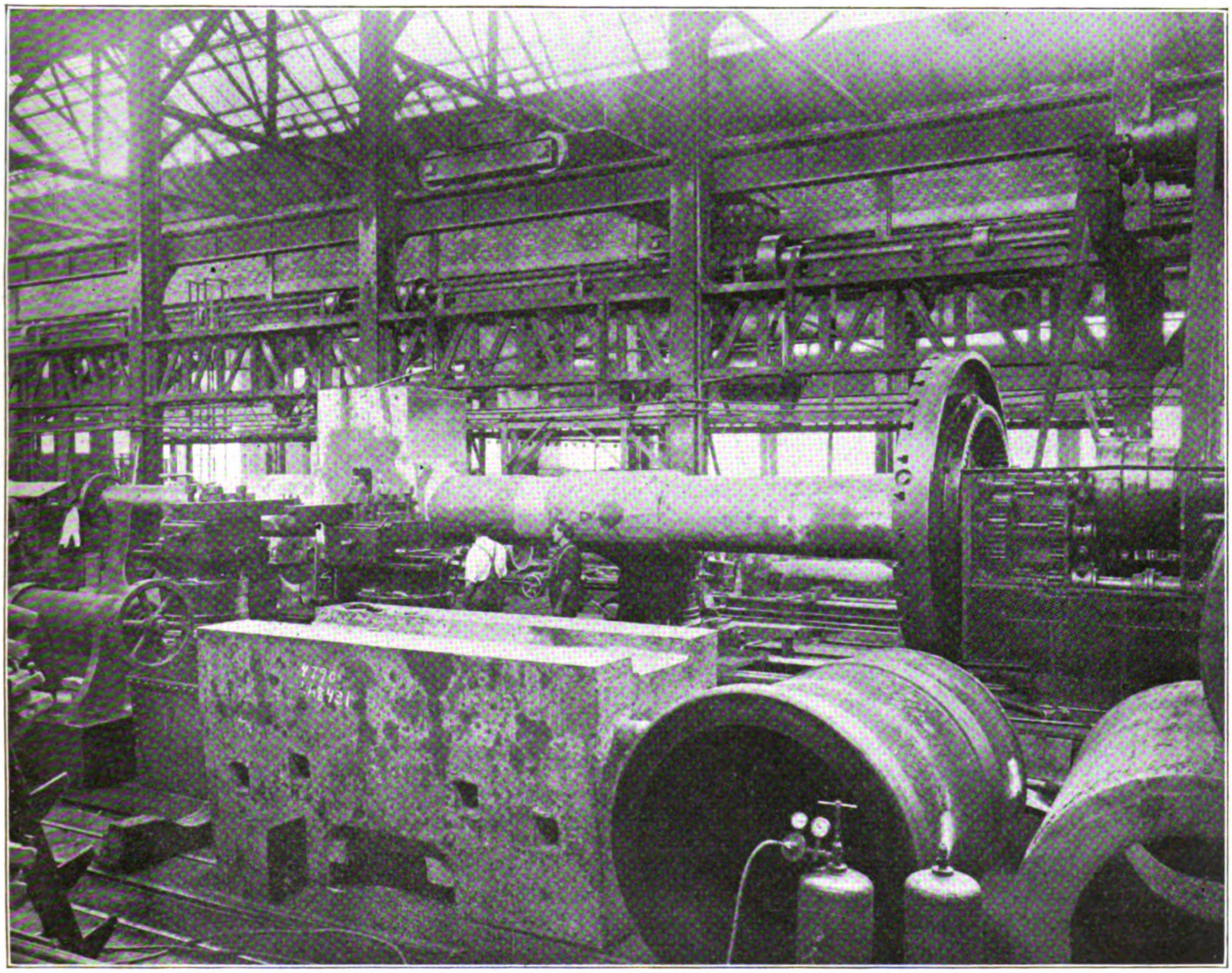
No. 3 Open Hearth.

This department makes a large variety alloy and special steels for the merchant mills. The furnace equipment consists of five 75-ton basic open hearth furnaces, and one 400-ton hot metal mixer. The furnaces are arranged for either gas or oil firing. The gas house equipment consists of 10 Hughes gas producers, with mechanical feed. One low type 10-ton Morgan charging machine, one 75-ton Alliance ladle crane serves the charging floor, one 75-ton and one 100-ton Alliance ladle cranes serve the pit side. The stockyards are served with two 15-ton Alliance and one 20-ton Pawling & Harnischfeger cranes, all equipped for lifting magnets. Waste heat boilers of 400 hp. rating are installed on each furnace. The fans for these boilers are driven by slip ring alternating current motors arranged for 30 per cent reduction in speed, by secondary control.

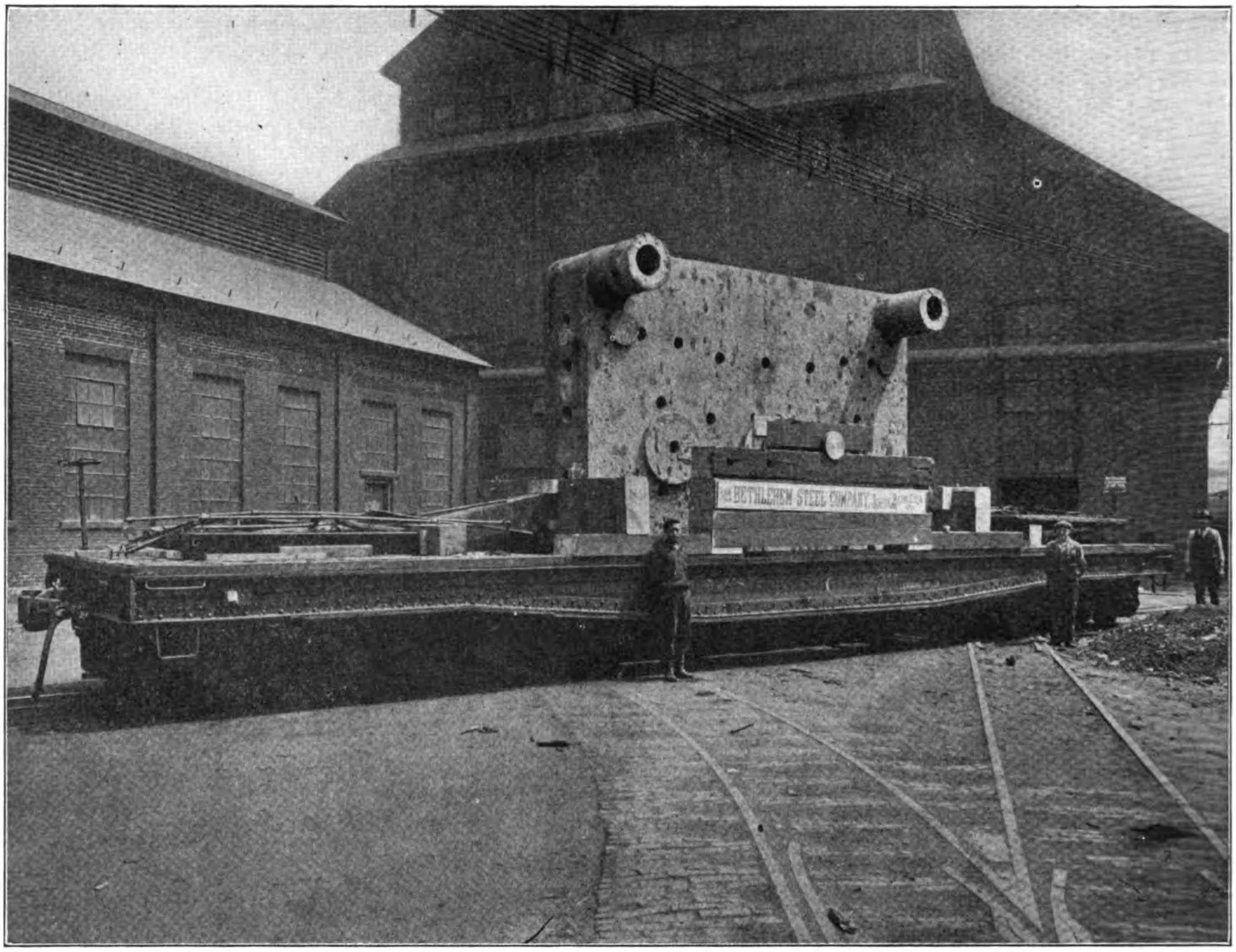
No. 2 Merchant Mills.

35-in. Blooming Mill.

This mill receives steel from the No. 3 open hearth. The ingots are stripped with a 15-ton stripper and passed directly into the soaking pit building, where they are handled by two 10-ton Morgan pit cranes. The soaking pits consist of four furnaces, four holes each. They are gas fired, taking the gas from eight Hughes gas producers, four additional producers furnish gas for the 22-in. mill and mill treatment department. The ingots are passed to the blooming mill over a roller line; the pit cranes placing



No. 2 machine shop. Machining single throw one-piece crankshaft.



A large steel casting from steel foundry.

the ingots directly on the rollers. The mill rolls are 35-in. pitch line diameter and 80 in. long, between housings. The side guards and fingers are motor driven; the side guards on two sides of the mill being connected mechanically through a long shaft. These motors operate in parallel and are rated 100 hp., Westinghouse No. 4/0 Mill Type. Mill tables are driven by two 100 hp. No. 4/0 Westinghouse series wound motors connected in series. The screw-down is operated by two No. 5 Westinghouse mill type motors connected in series. The roller operates the screw-down and approach table on separate masters. The roll drive and mill tables are connected to the same master controller, the first point on the master starts the roller line and the remaining points operate the mill drive motor. Foot operated switches are arranged so that either the tables or the mill drive may be operated without the other. The main roll drive was built by Westinghouse Electric & Manufacturing Company and consists of one double armature 1,200 volt motor connected in series with two 600-volt generators. The motor and generator armatures being connected alternately so that 600 volts is the maximum potential to ground. The generators are driven by a 2,000 hp., slip ring, a.c. motor, and a 50-ton fly wheel is arranged to absorb the peaks. The a.c. motor is controlled by a liquid slip regulator which limits the power drawn from the line to about 2,000 kw., and consists of three separate electrode compartments mounted above a concrete tank, the electrolyte being circulated through radiators into electrode tanks, and into the concrete tank or sump. This regulator operates without the use of cooling water, which is normally required in all other types of regulators. The normal operation of this mill is rolling 19-in. x 19-in. ingots into 4 x 4 billets; a high percentage of this material being alloy and high carbon steel.

No. 2—18-in. Continuous Billet Mill.

This mill consists of six stands, 18-in. x 27-in. rolls, and was built by Morgan Construction Company. Receives its blooms from the 35-in. mill as 4 x 4 and discharges square billets averaging from 1½ in. to 3½ in. square. The hot bed is of the Morgan flat escapement design. This mill does not operate to full capacity owing to the fact that a certain amount of the product of the 35-in. mill is passed directly to the 22-in. mill.

No. 2—22-in. Bar Mill.

This mill consists of three stands, 22½ in. x 30½ in. rolls, three high, one stand 22½ in. x 30½ in. rolls, two high. The steel is handled by two traveling tilting tables on each side of the mill. It is driven by an 1800 hp., General Electric two-speed motor, 250/125 rpm. through a gear reduction. Products rolled are

2⅜ in. to 8 in. rounds, 3 in. to 12 in. wide and ⅜ in. to 3½ in. thick flats, 2½ in. to 5½ in. squares.

No. 2—12-in. Bar Mill.

This mill consists of one stand three high 16-in. rougher, driven by an 800 hp., General Electric 100 rpm. motor and five stands, three high, 12½-in. rolls and one stand, two high, 12½-in. rolls, all driven by an 800 hp., General Electric two-speed motor running 214 or 167 rpm. The hot beds are 125 feet long, of the stationary type. The product is a large variety of rounds from ¾ in. to 2-11/32 in., ¾ in. to 2 in. squares, ¾ in. to 1¾ in. hexagons, ¾ in. to 1½ in. octagons and 1½ in. to 4 in. wide, 1 in. thick square inch plates. 1½ in. to 5 in. wide and ⅛ in. to 3.4 in. round edged flats and shapes.

No. 2—10-in. Bar Mill.

This mill consists of five stands three high rolls 10½ in. in diameter and one stand two high 10½ in. in diameter and one stand two high 10½ in. in diameter rolls driven by a 575 hp. General Electric, two-speed motor running 300 and 214 rpm. The hot bed is 100 feet long, of the stationary type. This mill rolls practically the same line of shapes and materials as the 12 in., except ½ in. is the smaller dimension.

No. 2—8-in. Bar Mill.

This mill consists of one stand three high 12-in. roughing rolls 12½ in. diameter, 48 in. long and driven by a 450 hp., 125 rpm., General Electric motor. Five stands of three high rolls 8½ in. in diameter, and one stand two high rolls 8½ in. diameter, driven by a 575 hp., General Electric two-speed 375/-250 rpm. motor. The hot bed is 100 feet long, of the stationary type. This mill rolls practically the same products as the 10-in. and 12-in. mills, except ¼ in. is the minimum dimension.

No. 3 Merchant Mills.

No. 3—12-in. Crucible Bar Mill.

This mill consists of two stands, three high, 16-in. roughing rolls, driven by a 500 hp., General Electric motor, 88.4 rpm., and five stands, three rolls (high), and one stand two high rolls driven by a 350 hp., two-speed, General Electric motor, 150/100 rpm. The products of this mill are practically the same as those of the No. 2—12-in. mill, except that the roughing stands are used for rolling high speed steel billets.

No. 3—9-in. Crucible Bar Mill.

This mill consists of one set three high, 12-in. roughing rolls driven by a 350 hp., General Electric 125 rpm. motor, and five sets three high 9½-in. rolls, one set two high 9½-in. rolls, all driven by a 350 hp., General Electric two-speed motor, 375/214 rpm. The product of this mill is practically the same as outlined for the No. 2—8-in. Mill.

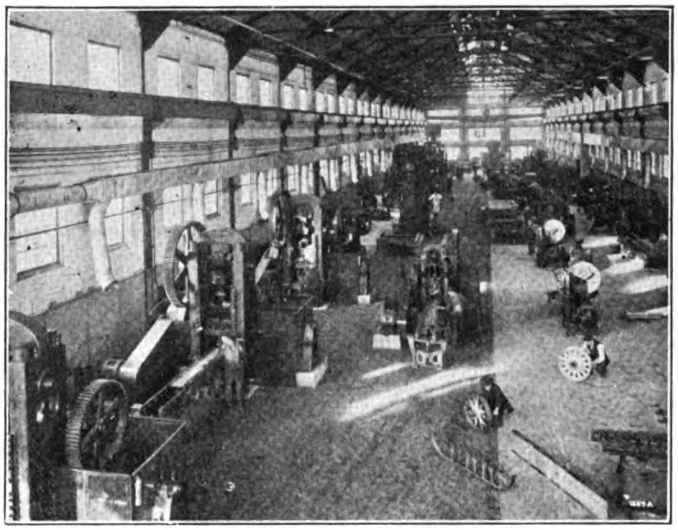
Brass Foundry.

The brass foundry equipment includes one 60-in. Schwartz Crucible pot furnace, drying ovens, moulding machine, etc. One centrifugal casting machine, 12-in. to 24-in. cylinders, 200 in. long, and one centrifugal casting machine 6-in. to 15-in. cylinder, 200 in. long. The larger casting machine is driven by two adjustable speed d.c. motors connected on either side of the driving pulley and so arranged that either motor can drive alone in case of failure of the other motor. The casting barrel is connected to this driving pulley with a heavy belt operating on 15 ft. centers. The smaller machine is driven by a single motor.

Regenerative breaking may be used in stopping these machines, since adjustable speed motors are used in both cases. The product of this department is all types of brass and bronze castings, including large cylinders for paper rolls or tubing used for ship shafting.

Treatment Departments.

Treatment departments in general include a large variety of furnaces and tanks for quenching, and a large number of furnaces for annealing. Of special mechanical interest is the No. 5 Tempering Plant, in which is located two vertical furnaces 90 feet deep, which may be fired by oil or coke oven gas. This department was designed for heat treating forgings as large as 20-in. guns, and is probably the largest department of its kind in America. It is equipped with a 225-ton crane, the hoisting motors of which are shunt wound and take power from a 400 kw. motor generator set. Speed control is obtained on the motor from zero to maximum speed by adjustment in generator votage and field weakening on the motor. The motors are capable of hoisting 225 tons at 30 feet a minute, 160 tons at 60 feet a minute, and 60 tons at 120 feet a minute. The motor generator set is driven by a 6600 volt synchronous motor and the braking energy is pumped back into the line.



Wheel shop. Punches in left foreground. Wheel after first bending operation in center foreground. Finished wheel in center and right foreground.

The other treatment departments are capable of handling all types and sizes of forgings and castings and they are divided into five operating units. In addition to these units the No. 2 merchant mill department is equipped with a treatment department. The projectile department has its own treatment department.

No. 8 Machine Shop.

This shop was designed and built for the manufacture of 16-in. to 18-in. guns. It contains 48 miscellaneous large machine tools, the rough turning lathes being equipped with 125 hp. adjustable speed motors. The shop is divided into two aisles, one being served by a 150-ton Alliance crane, and the other aisle by two 75-ton Pawling & Harnischfeger cranes. This shop is adjacent to No. 5 Tempering Plant and the tempering crane and furnaces are used for assembling large guns.

No. 2 Projectile Department.

This department is equipped for the manufacture of all sizes of projectiles, from 3 in. to 18 in. inclusive, in either the high explosive or armor-piercing types. It is also equipped for the manufacture of hardened steel rolls, die blocks, etc. The forging section is equipped with one 200, two 300, two 500 and one 1500-ton forging presses; two 6,000 lb. steam hammers. The treatment section contains eight car bottom furnaces, 17 lead pot furnaces, 54 quenching furnaces and 32 heating furnaces. The machine shop has a complete line of machine tools, all of which are motor driven. The building contains 150,000 sq. ft. floor space.

Ingot Mould Foundry.

This department makes a large variety of ingot moulds and stools. Equipment consists of one 400-ton hot metal mixer served by a 75-ton ladle crane, two 84-in. Whiting cupolas and one Jarring machine, complete machines and mixers and six core ovens. 16,000 sq. ft. is devoted to moulding; 30,000 sq. ft. to casting and cleaning, and 18,000 sq. ft. to stock house. All cranes are equipped for electric lifting magnets. Cupola blowers are driven by slip ring a.c. motors arranged for 30 per cent speed adjustment by secondary control.

Cinder Dump.

The cinder dump includes the scrap reclaiming department which is equipped with six cranes, all designed for handling 30,000 lb. drop balls with lifting magnets. One crane is also equipped with double drums for bucket handling and is used to pick up the open hearth slag after the steel scrap is reclaimed. All pig iron, scrap and miscellaneous storage is located on this area.

Direct current power is distributed along the tracks by means of overhead lines arranged with tapping-off points so that locomotive crabs can use lifting magnets in handling of magnetic materials.

Redington Proving Ground.

The proving ground is used primarily for proof firing guns and testing projectiles. It is equipped with a 100-ton Gantry crane driven with slip ring a.c. motors. Experimental work on shells and guns is also carried on in this plant. Power is transmitted to Redington at 6600 volts and stepped down to 220 volts for general consumption. A motor generator set also supplies a small amount of d.c. where needed.

Electrical and Mechanical Repair Shops.

The electrical and mechanical repair shops are lo-

Ingot mold foundry. Pouring platform. Coke ovens on left, cupolas on right.

cated in the same building, the mechanical repair shop being on the ground floor and is equipped for all kinds of mechanical repair work.

The electrical repair shop is on the second floor and is equipped for electrical repairs of all kinds. The armature winding department rewinds an average of 50 to 60 armatures per month, in addition to making minor repairs on a number of others. A limited number of armature coils are made in the shop; the majority of armature coils being purchased. Field coils and electro magnets are wound for use in the various lines of motors and controllers. Control apparatus and lifting magnets are also rebuilt. Electrical stores department is located on the same floor with the repair shop. It carries a complete line of materials needed in connection with repair work and construction.

Total motors in the Lehigh Division, 4,244.

Electric traveling cranes, including all sizes and types, 264.

Motors 200 hp., or larger, for constant speed, are operated at 6600 volts, three-phase, 25 cycles. Motors smaller than this are either 230 volts d.c., or 230 volts a.c.

Electrical Applications in Saucon Division of Bethlehem Steel Company, Bethlehem, Pa.

This division of the Bethlehem plants is at present devoted entirely to the making and rolling of structural steel. Saucon power requirements are supplied by the loop system previously mentioned, the power being received at 6600 v., and converted to 220 d.c. by means of two 2000 kw. six-phase rotary converters located in Sub-station No. 4, which is the old Saucon power house and contains, in addition to the converters, the following equipment:

Two 1000 kw., 80 rpm., engine driven generators, mentioned in early part of this paper, and held for standby service.

One Chicago Pneumatic Company air compressor delivering 2065 cu. ft. free air per minute, at 90 lb. pressure. Compressor is driven by a 350 hp. synchronous motor operating at 6600 v., 187.5 rpm.

One 2100 cu. ft. air compressor driven by a 17x 34x36 steam engine. This is held in reserve.

One steam blowing engine 46x84 and 84x60 cross compound, with flywheel, delivering 28,900 cu. ft. air per minute at 30 lbs. pressure when operating at 40 rpm., using steam at 150 lbs. This blower delivers air to Bessemer converters.

Power is also received at Sub-station No. 6 located at 18-in. mill where five 500 kw. rotary converters supply d.c. to the lower mills, bridge shop, yards and tilting O. H. furnace department.

Open Hearth Department.

The Bessemer section of the open hearth department consists of:

Three 20-ton Bessemer converters, used in "duplexing."

One 1300-ton hot metal mixer

One 1000-ton hot metal mixer.

One 400-ton hot metal mixer.

This operation is served by two 75-ton Alliance ladle cranes. The tilting furnace section (No. 4 Open Hearth), consists of:

Two 200-ton basic tilting open hearth furnaces, gas fired. The furnaces are equipped with motor driven tilting apparatus, and all electrical auxiliaries as valves, doors, etc. The section is served by:

Two 175-ton Alliance double trolley ladle cranes on pit side.

One 7½-ton Morgan low type charging machine.

Brass foundry. Showing large brass cylinders cast on the two centrifugal machines.

Two 100-ton Alliance ladle cranes on floor side.

Two 10-ton stockyard cranes.

The stationary furnace section (No. 2 Open Hearth), consists of:

Sixteen 75-ton stationary open hearth furnaces.

The waste gases are utilized by 18 waste heat boilers, rating as follows:

Ten 484 hp., six 523 hp., two 625 hp.

Boiler fans are driven by 60 hp., d.c., 300/600 rpm. motors.

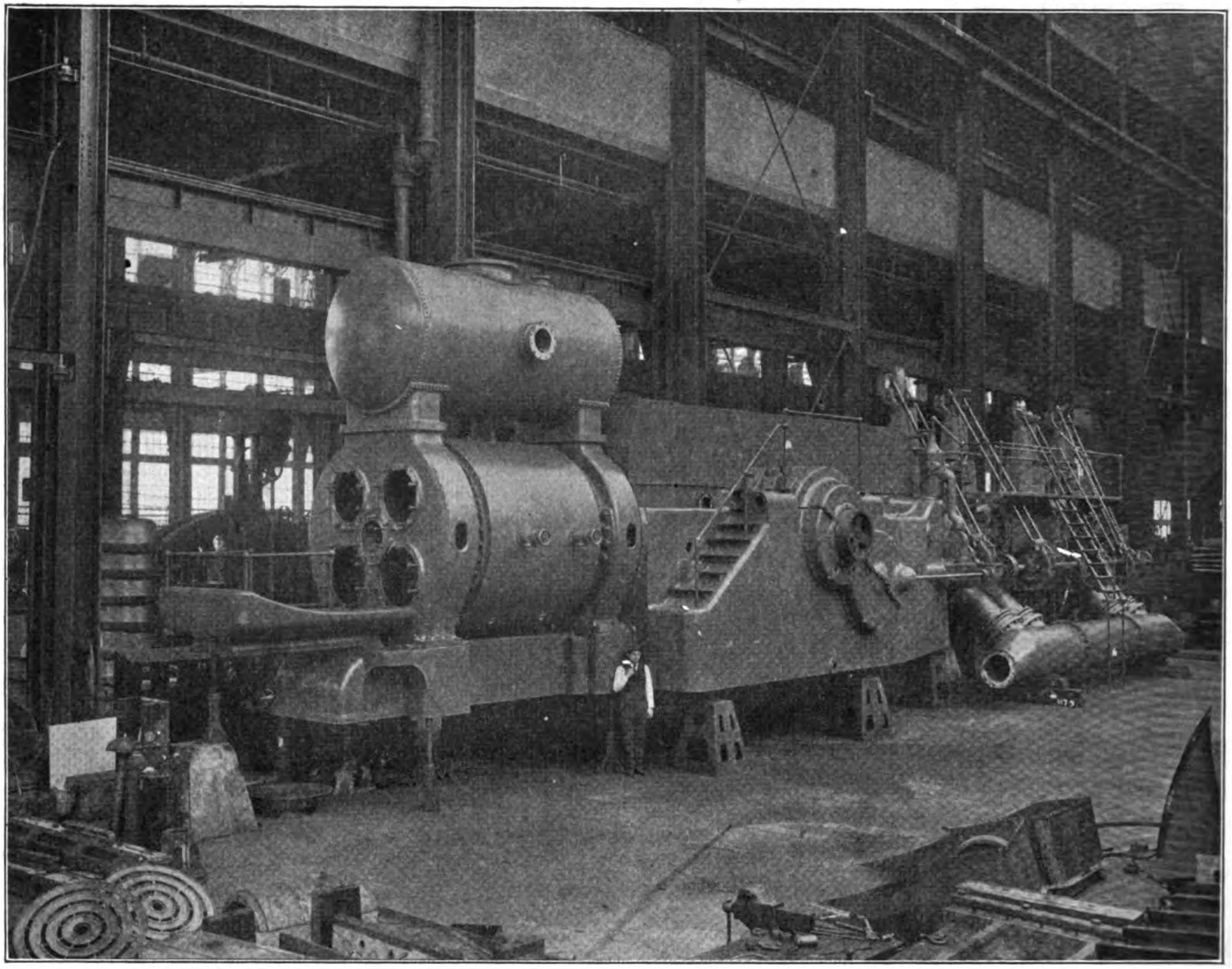
This open hearth is served by:

Three 100-ton Alliance ladle cranes on pit side.
One 125-ton Alliance ladle cranes on pit side.
Three 60-ton Alliance cranes.
Three 5-ton Morgan low type charging machines on floor side.
Four 10-ton, 84-ft. span stockyard cranes.
Three 20-ton, 83-ft. span, mould-yard cranes.
Stripping section consists of:
One 100-ton Morgan single stripper.
One 200-ton Alliance single stripper.

Soaking Pits.

No. 2 pits, serving 40-in. bloomer No. 2 and the 42-in. mill, consists of 16 pits, 8 ft. x 9 ft. each, and served by two 15-ton Morgan pit cranes.

No. 1 pits serving 40-in., No. 1 and 46-in. bloom-



No. 6 shop. Gas blowing engine assembled.

ers, consists of 44 pits 7 ft. x 9 ft. These pits are served by:

One 10-ton Morgan crane.
One 15-ton Morgan crane.
Two 7½-ton Alliance cranes.

Mills.

The 42-in. Bethlehem shape mill rolls—6-in. to 10-in. "H" columns—8-in. to 18-in. wide flanged beams—8-in. to 12-in. wide flanged girders.

The mill consists of 40-in. bloomer No. 2, and No. 1 and No. 2 stands of 42-in. main and supplementary mills finishing and delivering to a hot saw where steel is cut to order length and delivered to hot beds. Main drives are steam engines with all auxiliaries motor driven.

Forty-eight-in. Bethlehem shape mill, consisting of a 46-in. blooming mill with No. 1 and No. 2 stands of 48-in. main and supplementary finishing mills rolling—8-in. to 14-in. "H" columns—10-in. to 30-in. wide flanges beams—8-in. to 30-in. wide flanged girders.

The 46-in. blooming mill rolls are driven by a 40-in. and 66-in. x 54-in. Wm. H. Todd twin tandem compound reversing steam engine.

The 48-in. main finishing rolls and the 48-in. supplementary finishing rolls are each driven by a Wm. H. Todd 46-in. and 76-in. x 72-in. twin tandem compound reversing engine.

The 40-in. bloomer No. 1 rolls blooms and billets for use in 28-in. Struct. and 30-in. billet mills. The main rolls are steam driven and the tables are electrically driven. The manipulators are hydraulically actuated.

The 28-in. structural mill, three stand, three high structural mill rolling 6-in. to 15-in. beams and channels, 4-in. x 3-in. to 8-in. x 8-in. angles.

The 30-in. billet mill, single stand, three high Morgan mill driven by 1800 hp., General Electric 6600 v., three-phase, 25-cycle, 75-rpm., induction motor, rolling from 7-in. x 8-in. blooms to 4-in x 4-in. and 5-in x 5-in. billets, at an average power consumption of 11 kwh. per ton.

The 28-in. rail mill:

One two-high roughing stand driven by a reversing steam engine. One three-high intermediate stand, and one two-high finishing stand, both stands steam driven by the same engine.

The finishing end is equipped with hot saws, hot bed, and straightening department.

The 18-in. structural mill:

Morgan Engineering Company mill consisting of:

Two stands three-high, one stand two-high, driven by 1500 hp. Westinghouse type HF, 6600 v., three-phase, 25-cycles, motor with speed range of 135 rpm. to 81 rpm. Product, 3-in. x 3-in. to 5-in. x 5-in. angles. Three-in. to 6-in. standard beams.

The 12-in. structural mill:

Morgan Construction Company 16-in. and 12-in. mills consisting of:

Six stands 16-in. continuous roughing and four stands 12-in. Belgian type finishing. Driven by 2,000 hp. General Electric Scherbius set having a speed range of 65-83.3-100 rpm. on constant torque basis. Product 1¼-in. x 1¼-in. to 3-in. x 3-in. angles.

Structural Shipping Yards.

These yards offer exceptional facilities for promptly cutting and shipping a wide variety of structural shapes and sizes.

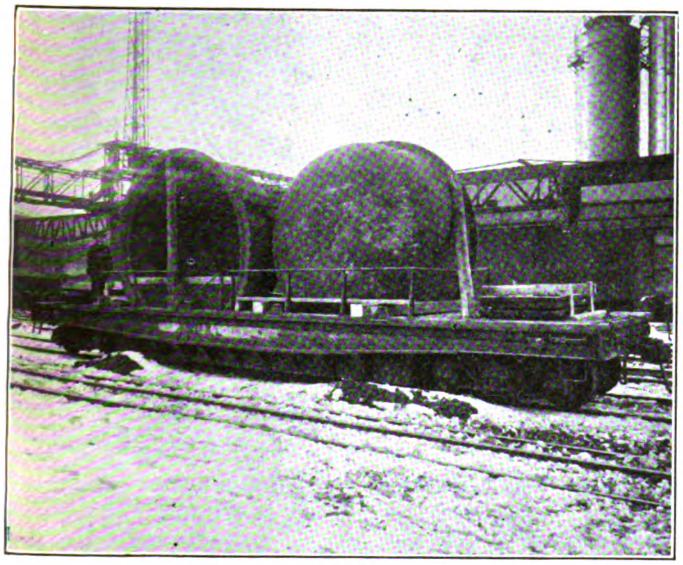
Area of yards is approximately 23 acres, covered by 14 crane runs served by 38 10-ton double trolley cranes; five 60-in. cold saws; two angle shears and one beam shear.

The yards carry two large stock, embracing approximately 650 different sections.

Fabricating Shops.

Three fabricating shops.

The mechanical, electrical repair shops, and roll turning shop are located in one building. The mechanical and roll shop occupy the first floor and the electrical repair shop the second floor. These shops handle the repairs and roll turning for the entire Saucon division.



Large iron castings.

Pumping Station.

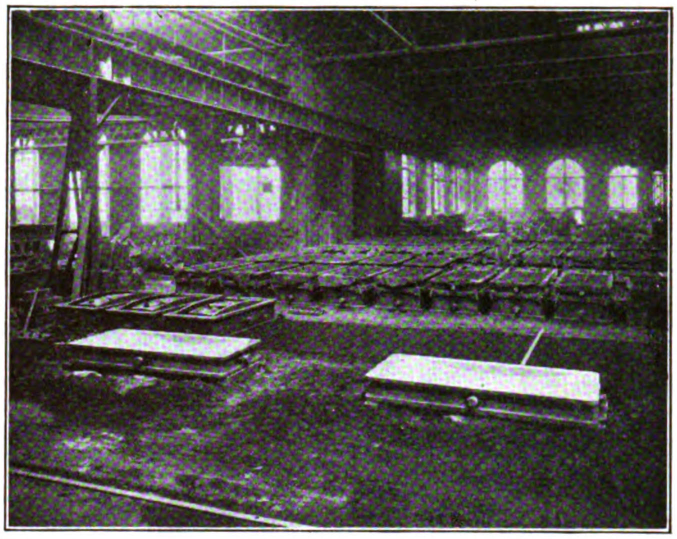
This station supplies practically all water for Lehigh and Saucon divisions. The equipment consists of:

Five motor driven pumps each with a capacity of 20,000,000 gallons in 24 hours, driven by five 525 hp. General Electric 750 rpm. induction motors.

Three steam driven pumps, with a unit capacity of 12,000,000 gallons each.

One steam driven pump, with a capacity of 18,000,000 gallons.

One steam turbine driven pump, with a capacity of 20,000,000 gallons.



Iron foundry. Flasks for tunnel segments ready for metal.

The total daily pumping capacity of this station is 175,000,000 gallons.

General Data.

Saucon Division operates 185 cranes, and 1,380 motors, exclusive of crane motors.

Detroit Societies Meeting

The Associated Technical Societies of Detroit held their annual meeting in the new home of the Detroit Engineering Society, 478 Alexandrine avenue, on Friday, June 22.

Mayor Frank E. Doremus was the honor guest, and he and several of the commissioners of city departments addressed the large gathering.

A. A. Meyer is chairman of the Associated Societies, E. M. Walker, vice chairman, and Walter R. Meier, secretary-treasurer.

It was announced that the Public Lighting Commission had let contracts for a new power station at the foot of Morrell street, to include four 20,000 kw. Westinghouse turbo units estimated to cost $1,250,000. These are to be in service within two years.

Fluospar in the Western States

A paper discussing the fluorspar resources of the western states has just been issued by the Bureau of Mines. An extensive investigation was undertaken by the author to determine the possibility of securing supplies of fluorspar suitable for steel mill purposes from the western part of the country.

Only a small tonnage of flourspar suitable for fluxing purposes is available. The deposits in general are small, and many of them are impure, making expensive treatment necessary. The small Illinois-Kentucky district will continue to be the main domestic source of supply for the demand which in normal times exceeds 200,000 tons yearly.

Digitized by Google Original from UNIVERSITY OF MICHIGAN

Coke Quality and Blast Furnace Operations

The Relation of Coke Consumption to Combustibility—A Review of the Work of Heinrich Koppers.

By **F. W. SPERR, JR.*** and **D. L. JACOBSEN†**

PART II

CREDIT is given to Wust, Director of the Institute for Iron Research, for being the first to show that the oxidizing zone produced in the burning of the coke just before the tuyeres causes a reoxidation of the iron. The reoxidized iron must again be reduced, thereby requiring an increased coke consumption. It is pointed out that it makes no difference whether we take the view that the primary product of coke combustion is carbon dioxide or whether we accept the theory that carbon monoxide is first formed and is immediately burned to carbon dioxide.‡ The existence of the oxidizing zone is not to be questioned.§ It is not only created by the oxygen brought in by the blast, but is in much larger measure due to the large quantities of carbon dioxide which are formed in the vicinity of the tuyeres.

It might be argued that the existence of this oxidizing zone and the consequent reoxidation of the iron could not actually cause an increased consumption of coke because it makes no difference whether the carbon dioxide is reduced directly by carbon or indirectly through the formation of ferrous oxide and from the standpoint of heat consumption, the same quantity of heat is of course liberated in the oxidation of iron as is consumed in its reduction. Koppers, however, points out that, under the conditions of blast furnace operation, the events occur in such a way that the heat quantities made available in the different reactions cannot reach any equalization. These reactions must be considered as occurring in zones or layers. The gases are making their way upward at great velocity. In the oxidizing zone, the heat produced is carried up by the gases while the oxidized solids sink downward. The secondary reduction of the solids thus oxidized must occur in lower zones and this secondary reduction must occur with the aid of additional quantities of heat other than those which were liberated in the oxidation.

Injury to Metal:

Fig. 6 has been prepared from data given in an article by Wust° and shows, in terms of the ratio of oxygen to nitrogen at different points in the melting zone of the blast furnace, the extent to which the oxygen in the gas phase is diminished in the neighborhood of the tuyeres. The injury caused by the oxidizing zone consists not only in increased coke consumption but in inferior quality of iron. The oxidizing action results in the formation of more or less ferrous oxide according to the extent of the zone. Some of this ferrous oxide goes into the metal and has a well recognized effect in reducing the mechanical strength of the pig iron. To the presence of the

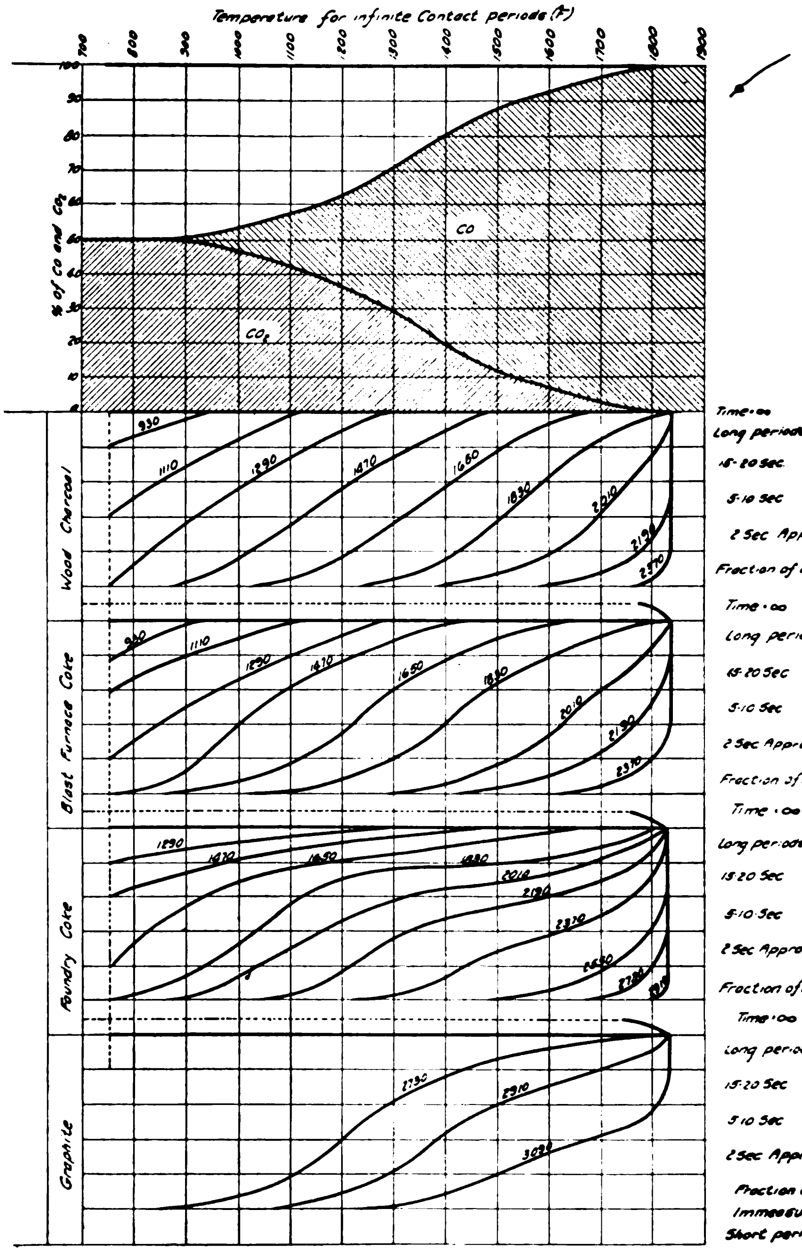


FIG. 4—*Diagram showing percentage of CO_2 and CO in equilibrium with solid carbon at different temperatures.*

---

*Chief Chemist, the Koppers Company.

†Research Chemist, the Koppers Company.

‡Rhead and Wheeler, Jr. Chem. Soc. (1911) p. 847. Reference is also made to a dissertation by Gwosdz published in Berlin.

§In the discussion, attention was called to Van Vloten's experiments defining the limits of the oxidizing atmosphere in the vicinity of the tuyeres (Stahl und Eisen, January, 1893, p.26).

°Internationales Kongress fur Bergbau und Huttenwesen, Dusseldorf, 1910, Seite 228. Abstracted Stahl und Eisen, October 5, 1910, p.1715-22.

ferrous oxide is due the phenomenon of "internally chilled castings," which is said to be the cause of much complaint among German foundry men since the war. In Koppers' opinion, making due allowance for the effect of the different sulphur content, much of the characteristic difference between charcoal pig iron and coke pig iron is due to the smaller ferrous oxide content of the former which in turn is to be attributed to the much smaller oxidizing zone existing in the charcoal blast furnaces. There is a great difference in the quality of charcoal pig iron and coke pig iron of the same chemical composition. The graphite in the charcoal pig iron is in the form of very small flashes, while in coke pig iron it occurs in large flakes. Ferrous oxide has a characteristic effect in producing these differences. It is also noted that the ferrous oxide formed in the oxidizing zone works unfavorably with respect to desulphurization. It has a strong cooling effect because the heat consumed in its reduction is very great and the net consequence is a cold and poorer iron.

Coke Quality in Relation to the Oxidizing Zone.

Recognizing the existence and injurious effect of the oxidizing zone, what can be done to limit it as much as possible? Much has been accomplished in this direction by the high temperature blast used in modern practice. Drying the blast also has a favorable effect. Any further improvement must, however, come from the use of fast burning coke.

The injurious effects which can be attributed to an oxidizing zone of too great extent run parallel with the effects that are observed when slow burning coke is used. These observations are readily explained by a consideration of the nature of the reactions involved. The combustibility of blast furnace fuel may be measured by the time required for converting the carbon to carbon monoxide. This can be an immeasurably short period, but it can also be much longer, so that the reaction can be followed in a measurable time. The carbon burns primarily to carbon dioxide. With excess carbon, reduction to carbon monoxide occurs at a more or less rapid rate depending on the quality of the fuel. The time interval required for the production of carbon monoxide is a measure of the size of the zone before the tuyeres in which carbon dioxide is present. With a less combustible fuel, this time interval is long and the oxidizing zone is large. The more combustible the coke, the smaller is this zone and the less is the amount of secondary oxidation which must be followed by secondary reduction.

Comparison with Charcoal.

Thus, it is of great practical importance to get some idea of the possible differences that may exist in blast furnace fuels with respect to combustibility. Charcoal may be taken as a typical fast burning fuel and much may be gained by a study of charcoal blast furnace practice. On this point, Wust is quoted as follows: "In operating with charcoal, the fuel consumption per ton of pig iron averages 336 lbs. less than when operating with coke in spite of the fact that the blast temperature is 540 deg. F. lower. This fact can be explained simply by the porous quality of the charcoal. The extent of the oxidizing gas zone is essentially limited by this, and less of the iron dropping down above the tuyeres is oxidized when operating with charcoal than when operating with coke. In Canada, it was recently found in the same blast furnace operating with the same burden, in one case with charcoal and in the other case with coke, that the air requirement with charcoal was only 65 per cent of that required for coke. The explanation for this is that in the coke blast furnace considerably larger quantities of iron are oxidized above the tuyeres than in the charcoal blast furnace. Every measure that is adapted to decrease the oxidizing action above the tuyeres will produce more favorable operating conditions."

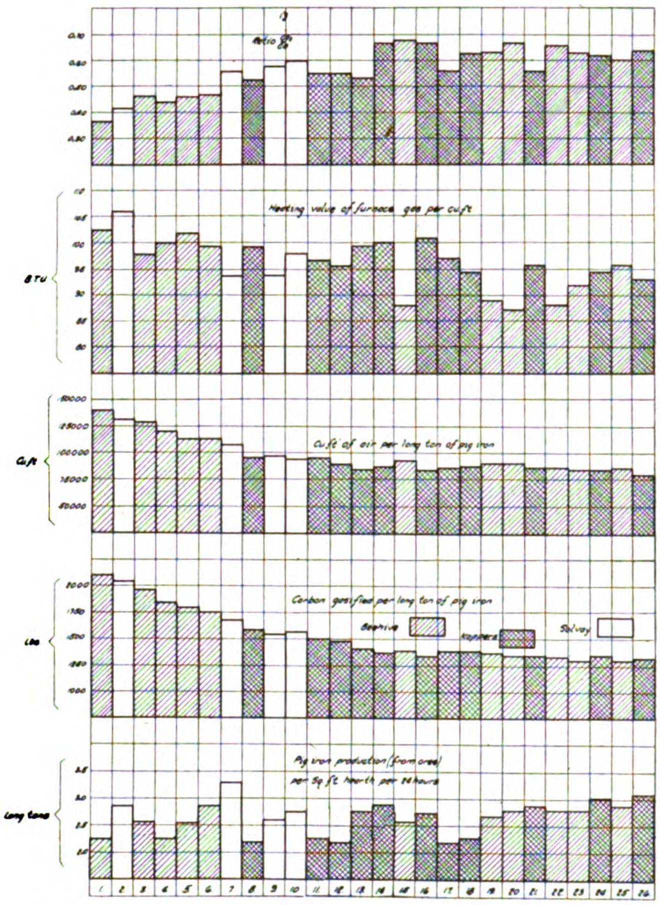


FIG. 5—*Another graphical summary of Howland's data. Discussed in Part I.*

Practical Deviations from the Carbon-Oxygen Equilibrium.

Charcoal is ordinarily made at low temperatures. If, however, by special means it is made at higher temperatures, its combustibility decreases. Blast furnace coke is essentially a high temperature product and its combustibility is less than that of charcoal and decreases as its temperature of production increases. The requirements of foundry practice are still higher temperature than blast furnace coke*. Thus, we have a series of fuels of decreasing combustibility starting with charcoal and ending with

---

*Charcoal is made at a temperature of 1000 to 1200 deg. F. Koppers' figures for the temperatures at which coke is produced appear too low. In America, the temperature of by-product blast furnace coke as it is pushed from the ovens may be from 1700 to 2000 deg. F., and foundry coke may be pushed from 100 to 200 degrees higher, although this is not always the case.

Table 4. Measurements and Capacities of Blast Furnaces according to O.Simmersbach

			Foundry Pig Iron								Hematite							Bessemer and Thomas Iron				
Furnace No.	1	2	3	4	5	6	77	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Available cubical capacity, cu.,ft.	4873	8050	7909	6356	7485	8193	18220	16101	11480	7803	7909	8299	14510	20020	18890	21260	24190	12780	11120	15220	14870	15360
Daily production long tons	59.1	76.8	83.7	88.6	88.6	88.6	108.3	157.5	157.5	88.6	93.5	98.4	167.3	172.2	182.1	216.5	452.7	108.3	127.9	137.8	147.6	196.8
Daily production long tons per sq. ft. hearth area	1.591	1.720	1.591	2.625	1.829	1.683	1.855	1.290	2.379	1.829	1.774	1.720	1.520	1.098	1.364	2.507	2.250	1.180	1.921	1.265	1.235	1.903
Blast temperature °F.	840-1110	1330-1510	1380-1470	1470	1470	1470-1650	1290	1200-1290	1540-1800	1560	1470-1510	1290-1470	1470-1560	1110-1290	1330-1400	1400-1800	815*)	1380	1380	1110	1380	1470
Coke Consumption, % of pig iron	106	119	104	117	117	119	114.6	103	117	99	100	104	107	97	117	116	91	128	114	122	104	91
Time of transit, hours	24	22	16	21	22	17	24	18-20	27	20	15	20	24	19	22	30	10-12	15	16.5-17	20-22	25	18
Slag,% of pig iron	80	103	56	104	90	88	103	84	75	51	53	65	49	49	52	50	49	107	107	97	104	80
CO_2, - - - - - - - -%	12	10	10	10.5	10	13	14	11.5	6	12.5	10	12	7.25	10	7.2	7.9	13.56	12.4	11	7.3	12	13
CO - - - - - - - -%	24	24	28	26.85	25	28	12	27.6	31.4	24	28	23	30	30	30.2	28.7	25.32	27.28	28	30.6	24	26.5
CO_2/CO - - - - - -	0.5	0.42	0.36	0.39	0.4	0.47	0.56	0.416	0.19	0.52	0.36	0.52	0.24	0.31	0.24	0.28	0.58	0.52	0.39	0.24	0.5	0.49

		Bessemer and Thomas Iron					Open Hearth Iron								Spiegeleisen			Ferromanganese		Ferrosilicon	
Furnace No.	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
Available cubical capacity,cu.ft.	21260	10880	20300	21400	11230	16350	10170	14410	18080	20080	15500	16210	23660	8827	12920	8827	12920	8827	13270	22950	12990
Daily production long tons	275.6	275.6	442.9	462.6	113.2	167.3	187.0	196.8	196.8	246.0	305.1	344.5	442.9	98.4	162.4	64.0	147.6	61.0	88.6	226.4	123.0
Daily production, long tons per sq. ft.hearth area	2,049	2,653	2,973	2,708	1,306	1,244	1.811	1,491	1,619	1,573	2,259	2,552	2,206	2.927	1.665	1,894	1,557	1,802	0,892	0,988	1,272
Blast temperature °F.	1560	1380	1400	1360	1290	1290-1470	1290-1380	1110	1290-1470	1110-1290	1350	1290 1560*	815*)	1470	1290-1650	1470	1290-1650	1290-1470	1380	1078	1380-1560
Coke consumption, % of pig iron	103	114	104	96	100	102	108	102	98	86	98	103	90	111	111	155	156	259	206	151	215
Time of transit, hours	22	11	10	12	20-21	12-13	14-16	18	16-18	18-19	15	15	10-12	24-25	25	24-25	26-27	12	20	10-12	14
Slag,% of pig iron	90	73	62	58	75	60	47	80	65	51	54	65	53	85	65	95	58	114	100	66	68
CO_2 - - - - - - - -%	12.6	7.5	8.3	8.6	8.2	10.5	9.6	11	14.4	14.5	10.4	10	13.91	11	11.4	10	10	7.3	6.6	6.8	4.65
CO - - - - - - - -%	28.6	32	31.4	29.6	31	24.5	29	28	24.2	24	28.6	25.5	24.95	28.5	28	28	29.9	29	31.6	32.8	31
CO_2/CO - - - - -	0.44	0.23	0.27	0.29	0.26	0.42	0.33	0.39	0.59	0.6	0.36	0.43	0.56	0.39	0.4	0.36	0.33	0.25	0.21	0.21	0.15

*) 17 and 35 are American furnaces.

foundry coke. We might even go further and place graphite on the list as representing a fuel of minimum combustibility.

For a comparison of these different fuels, Koppers has prepared the very instructive diagram shown in Fig. 4. The upper part of this diagram is the well known carbon-oxygen equilibrium diagram of Boudouard. This shows the percentage of CO_2 and CO in equilibrium with solid carbon at different temperatures. This diagram holds equally good for all forms of carbon whether as charcoal, as coke, or even as graphite and shows the relations commonly used in discussions on this subject. These relations are not, however, correct for practical conditions because in the Boudouard diagram, the time of contact is considered to be infinity; that is, the curves are correct only for a very long action between oxygen and the fuel. In all metallurgical processes as, for example, in the action of air on coke the time element is very short. The gases remain in the blast furnace only a few seconds and the conversion of carbon dioxide to carbon monoxide before the tuyeres must take place in an extremely short time. Therefore, from the Boudouard equilibrium alone, nothing can be learned that will be applicable to blast furnace operation.

Koppers has, therefore, added to the Boudouard diagram a series of curves based on the investigations of Clement, Adams and Haskins.† These curves show the deviations from the equilibrium with different times of contact. For example, consider oxygen passed over blast furnace coke heated to 2010 deg. F. in such a way that the time of contact is 5 to 10 seconds. Following the curve for 2010 deg. in the blast furnace coke section to the space marked 5 to 10 seconds and then going up vertically from this to the Boudouard diagram, we find that the products of combustion would contain about 5 per cent carbon dioxide, whereas at complete equilibrium at this same temperature the products of combustion should contain no carbon dioxide. In the case of foundry coke at a temperature of 2370 deg. F., the gases after a 2-second contact period would contain about 10 per cent CO_2. With the same coke and a time of contact from 15 to 20 seconds, the gases would contain practically no CO_2.

Relation of Coke Consumption to Combustibility.

The deviations from equilibrium occur for all fuels and are greater to the degree that the fuel is slower burning and to the degree that the time element is shorter. In the blast furnace process, the time element is fixed and if we wish to achieve improvement we must act on the fuel and provide that quality which makes possible the desired result. In this case, the desired result is the rapid conversion of carbon dioxide to carbon monoxide. The necessary quality is combustibility. Our efforts should, therefore, be directed toward making and using coke of as high a degree of combustibility as is consistent with the requisite strength. How to make such coke will be discussed later. Let us for the present continue to consider the action of coke in the blast furnace.

Fig. 7 shows a comparison of blast furnaces investigated by Howland and Gillhausen on the basis of the quantity of carbon gasified before the tuyeres per ton of pig iron. **The differences are very large and are to be attributed mainly to differences in the quality of the coke.**

---

†Bull. No. 7, U. S. Bureau of Mines—"Essential factors in the formation of producer gas".

Fig. 8 shows the carbon consumption of the blast furnace and the course of the ratio $CO_2/CO = M$ according to Gruner's Ideal for fast burning and slow burning coke. This figure shows how with fast burning coke the carbon consumption per ton of pig iron decreases with increasing direct reduction and how incomplete reduction can occur if too little coke is supplied. It also shows how the coke consumption increases with slow burning coke. In the latter case, more and more producer gas is formed and finally incomplete reduction occurs because of excessive reoxidation of iron.

Slow Burning Coke Produces Excess Gas and Hot Tops.

These considerations bring us to another disadvantage of slow burning coke viz. the formation of excessive amounts of gas which carry excessive quantities of heat into the shaft. There has been some discussion as to whether excessive accumulation of heat in the shaft can be attributed to the use of slow burning coke and some German metallurgists have been inclined to disagree with Koppers on this point, asserting that the contrary is the case and that hot shafts and hot tops are due to the use of coke which is fast burning. There is, however, abundant confirmation of Koppers' opinion. C. R. Meissner, who has contributed to the written discussion states that, in his experience in American practice, blast furnaces which have been operated with slow burning coke have had a tendency to hot tops and low hearth temperatures. When these same furnaces are operated with fast burning coke, they show cool tops and high hearth temperatures with increase in iron production and decrease in coke consumption per ton of iron. The fact is that the use of slow burning coke always entails excessive fuel consumption. This excess fuel must go out in the form of gas, carrying with it large quantities of sensible heat and unduly raising the temperature of the materials in the shaft.

Now, any overheating of coke tends to make it more brittle and reduce its combustibility, so it follows that the excess heat carried by the gases into the shaft has the effect of injuring the quality of the coke. The long period of overheating that coke must undergo in blast furnace operation is illustrated in the right hand diagram of Fig. 9, Part III, which show the usual temperature profile of the blast furnace. For the long distance in which the coke is overheated, practically no useful work is performed so far as any action of the coke is concerned. The conditions in this respect are much worse in German than in American practice. Koppers states that the best German coke furnaces have a time of transit of 20 to 24 hours as compared with 9 to 10 hours for American furnaces. The old charcoal furnace had a time of transit of only 5 hours.

Removal of Excess Gas.

As a remedy for the conditions, due to the passage of excessive quantities of hot gas through the shaft, Koppers proposes to remove the excess gas at a point between the melting and reducing zones. His idea is essentially to remove sufficient gas to maintain a uniform temperature in the shaft, irrespective of the quality of the fuel used; the temperature being kept as low as is consistent with the accomplishment of necessary reactions. Fig. 10, Part III, shows quantities of the different materials descending and ascending through three different blast furnaces. The gas diagram for the Howland furnace No. 19, is drawn so as to show what the condition would be if part of the gas were withdrawn from between the melting and reducing zones. In all cases, under ordinary operating conditions, the weights of the gases passing upward are greater than the masses descending through

Table 5

	According to Gillhausen (Dissertation)				According to Ledebur		According to Richards	According to Howland
	10% Spiegel	Basic Iron	Hematite	Thomas Iron	Coke Blast furnace at Ormesby. Gray Pig Iron #3.	Charcoal Blast furnace at Vordernberg. White puddling pig Iron	Charcoal Blast Furnace at Herrang.	Howland Furnace #19
Si -%	1.13	2.40	1.58	0.58	1.2	0.152	0.60	1.56
Mn -%	10.57	0.36	2.62	1.64	0.5	2.220	0.025	0.75
P -%	0.085	0.059	0.065	1.65	1.3	---	0.012	0.075
S -%	0.019	0.011	0.052	0.155	---	---	0.007	0.035
Cu -%	0.20	---	---	0.107	---	---	---	---
C -%	4.69	4.30	4.31	3.21	3.4	3.122	2.70	4.00
Burden - Lb. per long ton pig iron	6483	5478	5994	6222	5465 1400 } 6865	4764 311 } 5075	3427 260 } 3687	3965 76 777 } 4818
Per long ton pig iron								
Coke - Lb.	2696	2564	2078	2828	2464	1658	1528	1673
C - Lb.	2210-105	1919 - 96	1653 - 96	2124-72	2278-76	1443-69	1228-60	1481-99
C Gasified - - - - - - - - - - - - - - - - - - Lb.	2105	1823	1557	2052	2202	1374	1168	1382
C Gasified at tuyeres - - - - - - - - - - - Lb.	1716	1541	1317	1698	1727	1111	966	1180
Slag produced - - - - - - - - - - - - - - - Lb.	1848	970	1561	1680	3515	1443	495	ca. 1344
Furnace gas - - - - - - - - - - - - - - Cu. ft.	168,700	144,200	124,700	164,500	179,500	106,200	92,390	114,000
Furnace gas - - - - - - - - - - - - - - - - Lb.	13,626	11,593	10,255	13,220	14,858	8,886	7,905	- - - -
Air (60°F.-30 in. Hg.) - - - - - - - - Cu. ft.	125,200	112,200	95,810	123,800	125500-11083 lb.	81360-6220 lb.	70690-5770 lb.	88,860
Blast temperature - - - - - - - - - - - - °F.	1360	1423	1350	1290	1440	570	---	ca. 1110
Top " - - - - - - - - - - - - °F.	660	410	394	405	774	343	---	340
Furnace Capacity - - - - - - - - - - - - Cu.ft.	7591	15,040	15,040	21,350	20,620	---	---	20,200
CO_2 -%	11.4	8.4	12.56	8.01	CO_2/CO = 0.542	15.4	14.8	15.1
CO -%	27.9	30.5	27.27	32.94	---	25.6	23.1	23.6
CH_4 -%	2.59	0.7	0.74	0.76	---	0.6	0.5	---
H_2 -%	2.3	1.9	1.64	1.68	---	1.2	4.3	2.8
N_2 -%	55.81	58.5	57.79	56.61	----	57.2	57.3	58.6
Daily production - - - - - - - - Long-Tons.	66.4	167.2	196.8	346.2	62.0	14.8	---	579.7
Iron in burden - - - - - - - - - - - - - - - -%	30.58	38.15	38.15	35.77	30.6	42.5	40.5	46.5
Air(60°F.-30 in.Hg.)cu.ft/min./long ton p.iron	5,780	15,110	13,090	29,800	5,398	---	834	34,980
Air(60°F.-30 in.Hg.)cu.ft. per lb. C gasified per long ton pig iron - - - - - - - - - -	59.76	61.62	61.62	60.27	57.06	59.09	60.27	61.96
C gasified by oxygen of air in tuyeres - -%	81.8	84.6	84.6	82.8	78.4	81.3	82.6	85.0
C consumed in direct reduction - - - - - -%	18.2	15.4	15.4	17.2	21.6	18.7	17.4	15.0
Slag - per long ton pig iron - - - - - - Lb.	1848 with 3.7 CaS	970 with 7.36 CaS	1561 with 3.65 CaS	1680 with 3.97 CaS				

the furnace and since the specific heats are about the same, it follows that with increasing coke consumption and consequent increased gas production, a greater accumulation of heat in the shaft is bound to occur. This can be controlled by suitable means for removal of the excess gas.

With such means, it should be possible to decrease the height of the furnace, making temperature profile shown on the left hand side of Fig. 9. The indirect reduction in the shaft occurs best below 1650 deg. F., because at this point, carbon dioxide begins to oxidize iron and carbon. The removal of the excess gases would make it possible to secure the most favorable temperature condition through the greater part of the shaft. Moreover, since the gas passing up through the shaft always carries an amount of carbon monoxide, greatly in excess of that required to reduce the ores, the decrease in the velocity of the gas in the shaft resulting from withdrawal of the portion just below the reducing zone will increase the time of contact between the carbon monoxide and the ore and reduction will be more efficiently performed.

This proposal has aroused considerable discussion, receiving both indorsement and objection. The means proposed by Koppers for effecting the withdrawal of the gases consist in a water cooled pipe with openings in the bottom placed clear across the blast furnace and made strong enough to carry the burden. ("Ein wassergekuhltes, nach unten offenes Rohr, welches quer durch den Hochofen gelegt ist und welches genugend steif ist, um die Last zu tragen.") The gases are to be passed through waste heat boilers for the utilization of their heat and being rich in carbon monoxide would be very useful for fuel purposes. The idea of maintaining in constant service a water cooled pipe extending all the way through a blast furnace just below the reducing zone is naturally viewed with considerable distrust by practical operators, whose inclination would be to endeavor to find some other means of carrying out the proposal.

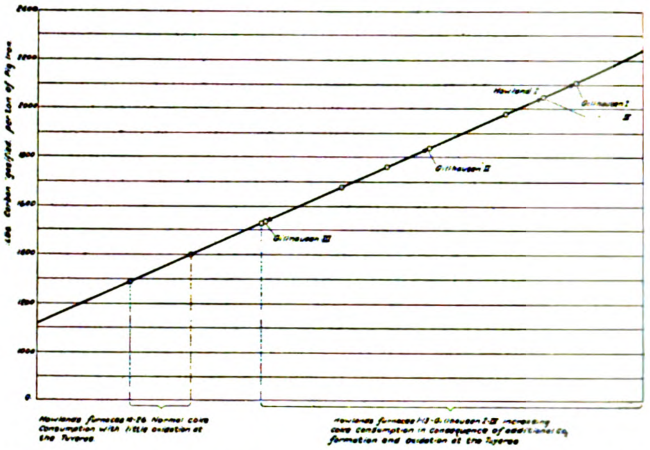


FIG. 7—*Comparison of blast furnaces on basis of carbon gasified.*

The proposal requires a careful study, from a

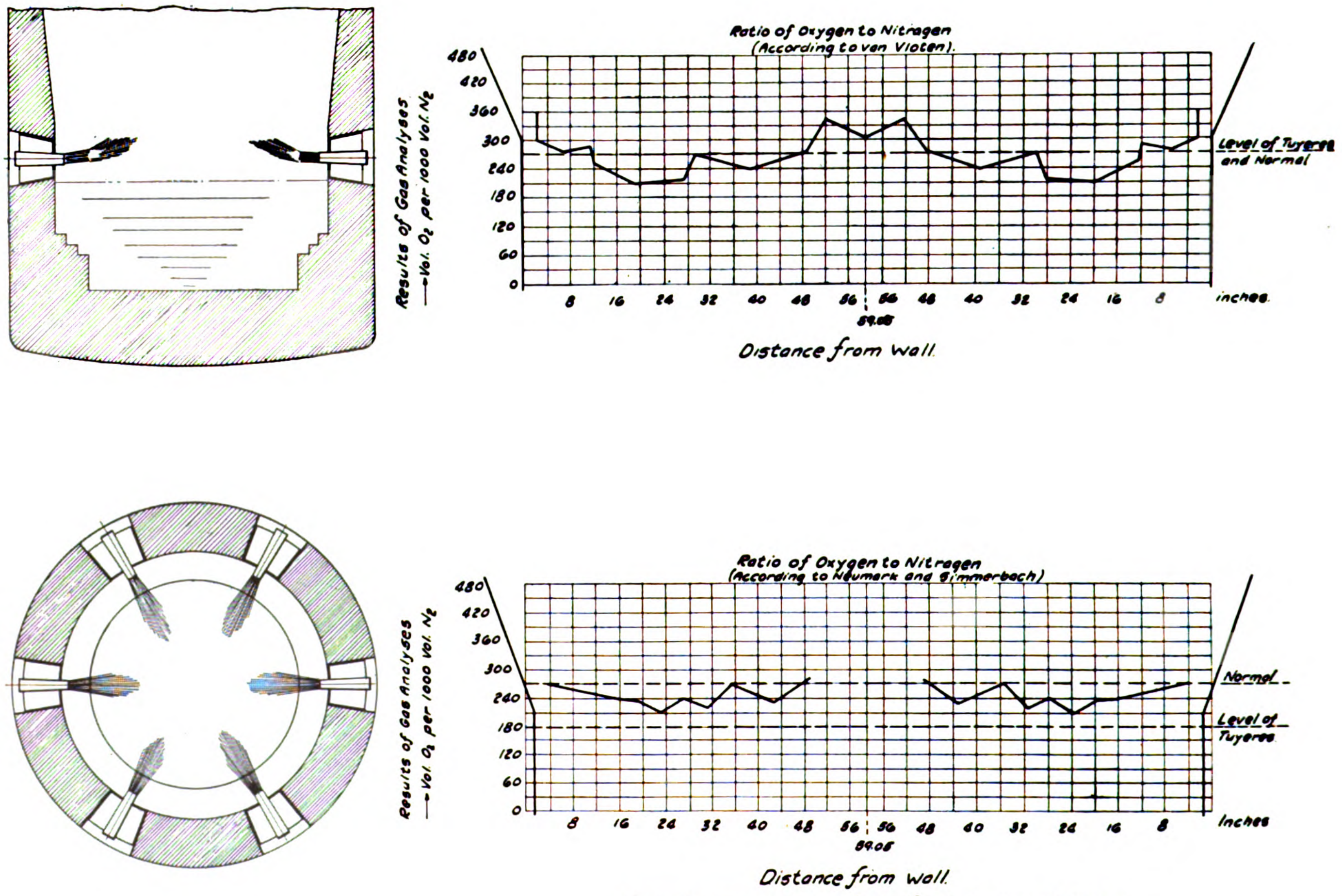


FIG. 6—*Curves showing the extent to which the oxygen in the gas phase is diminished near the tuyeres.*

physical-chemical standpoint of the new conditions that would occur in the shaft after withdrawal of a portion of the gas, the remaining gases carrying a relatively smaller percentage of carbon monoxide. Any considerable slowing of the rate of reduction, due to dilution of the carbon monoxide, might offset the advantage gained from a temperature standpoint. Koppers states* that where fast burning coke is used, producing normal grades of iron and with proper ratio of coke to burden, the withdrawal of gas is not necessary. Any solution of the coke by the carbon dioxide in the shaft has a cooling effect because the reaction $CO_3 + C = 2CO$ is strongly endothermic, absorbing 5831 Btu. per pound of carbon gasified. This solution of carbon is not to be regarded as harmful, but is necessary and beneficial, making possible a fairly definite separation of the reducing and melting zones. The melting zone must not extend into the shaft, where it is of prime importance that the materials remain solid to favor the necessary reactions. Moreover, the carbon solution reaction tends to keep the coke relatively cooler than the surrounding gases and to preserve its fast burning quality.

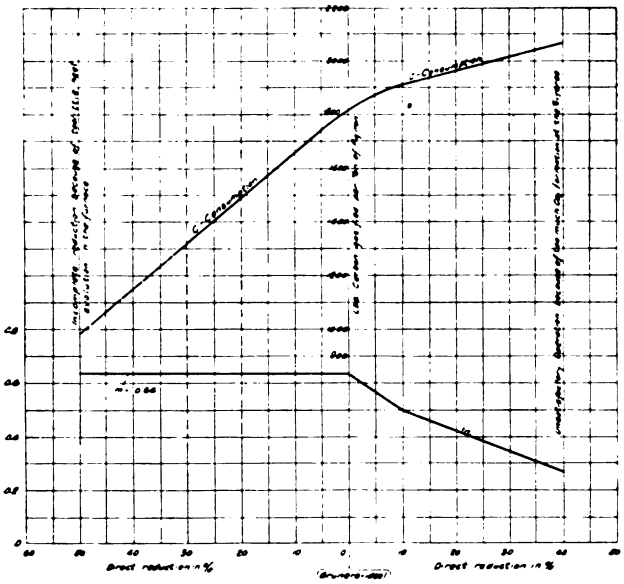


FIG. 8—*Curves showing carbon consumption and ratios of* CO_2*—CO.*

The withdrawal of gas according to Koppers is to be applied in the following cases:

1. When the furnace is working with too slow burning coke.
2. In case more coke is supplied for the purpose of gas production than is necessary for ore reduction.
3. In the production of certain kinds of iron which necessitate large quantities of coke.

---

*Stahl und Eisen, April 13, 1922. Page 569.

(Concluded in August)

World Trade in Steel Rails

Germany was, before the war, the leading exporter of steel rails and the United Kingdom was second. Since that time the exports from these two countries have been markedly curtailed, leaving the United States in the lead with 71 per cent of its prewar export tonnage. German productive capacity appears to have been impaired for some time to come, but British exports have been increasing steadily since 1919 while those from the United States have been decreasing, so that it is not impossible that the United Kingdom may soon again forge ahead of the United States as an exporter of rails.

Up to about the beginning of the century the United Kingdom was easily the dominating figure in the international rail trade. Until the outbreak of the war, British exports had declined only slightly but those of the United States and Germany had increased, particularly the latter, in the years just before the war. From 1908 to 1913 German exports increased from 331,323 to 500,835 metric tons, or 51 per cent, while United States exports increased only 27 per cent from 1900 to 1913. Table A shows German exports of steel rails, by countries of destination, for the five prewar years from 1909 to 1913 and for the year from May, 1921, to April, 1922.

TABLE A—EXPORTS OF STEEL RAILS FROM GERMANY

Country	1909-13 (5-yr. aver.)	*1921-22
	(In gross tons)	
Argentina	71,925	17,558
United Kingdom	34,937	†
Sweden	34,141	†
Dutch East Indies	31,891	16,701
Netherlands	28,299	43,431
Japan	27,231	14,294
Switzerland	20,944	†
Turkey	20,352	†
Brazil	18,171	9,811
Chile	17,914	†
British South Africa	16,014	†
German East Africa	14,240	†
China	14,166	†
Belgium	13,161	†
Denmark	9,927	†
Australia	9,424	†
British India	8,017	†
Other countries	86,494	§116,022
Total	477,248	241,185

*Year ending April 30.
†Not reported separately.

Formerly Argentina was Germany's chief customer, although neighboring countries of Europe were important buyers. Since the war the bulk of Germany's rail exports have gone to European countries. North Russia has been a large purchaser, and the great disorganization and destruction of Russian railways indicate that that country may be expected for some time to furnish an extensive market for rails, which Germany is conveniently located to supply.

The destinations of British exports of rails are shown in Table B. India continues to be by far the

TABLE B—EXPORTS OF STEEL RAILS FROM UNITED KINGDOM*

Country	1909-13 (5-yr. aver.)	1919	1920	1921	1922
		(In gross tons)			
British India	98,474	47,658	25,646	68,806	105,889
Argentina	90,082	127	7,598	32,259	12,061
Australia	88,720	112	54	1,132	23,070
Cape of Good Hope and Natal	34,852	1,102	2,678	9,457	†9,830
New Zealand	23,226	12,431	1,851	16,247	6,702
Brazil	20,403	22	1,798	935	‡
Portugese East Africa	12,822	1,124	16,593	3,268	2,743

(Continued on page 388.)

The Significance of the Ruhr Invasion

Possession of Ore by France and of Coal by Germany Determining Factor.

By **PARIS CORRESPONDENT**

This article written expressly for this magazine by a member of the Paris staff of the American Press Association, gives a bold but rational exposition of the deep, underlying causes which have resulted in the present impasse. The author has spent many years in France and Germany studying the economic and political problems of both. He suggests a solution.

THE influence of the "Comité des Forges" upon the decision adopted by the French government concerning the Ruhr raises the entire question of the relations and respective positions of the French and of the German metallurgical industries.

Since the French—and the Belgians—are in the Ruhr, the accusation has been repeatedly made that the policy pursued by France in the Ruhr is aimed less at obtaining reparations and the guarantee of security against a German *revanche,* than at the subjection of German metallurgy and coal mining to French metallurgy, which aspires to dominate the European market. The real aim of the French occupation of the Ruhr is represented by the accusers to be the establishment of the supremacy of the French heavy industry over the German "Schwerindustrie."

The organs of the "Comité des Forges" and those of the French government have energetically denied these allegations.

The enigma is difficult to unravel. It goes without saying that if a secret understanding has been established between the Quai d'Orsay, where the French Foreign Office is located, and the Rue de Madrid, where the headquarters of the "Comité des Forges" is located, no state secret would be better kept. It is, therefore, difficult to arrive at any conclusion based upon trustworthy evidence.

The presumption upon which was based the grave accusation that the French metallurgical industry influenced the decision of the French government and incited it to enter the Ruhr, are numerous and of various kinds.

The Comité des Forges undoubtedly has possessed considerable political influence since the last general election of November 16, 1919. A great many deputies of the majority party of the Chamber of Deputies, called "Bloc National," owed their election to its support—financial and otherwise. The Comité des Forges, therefore, has at its disposal, in the Chamber of Deputies, a great number of votes, roughly estimated at more than 200. In a chamber of 600, where the right and the left never vote together, this center party of 200 holds the balance of power and has the government at its mercy. The influence of the Comité des Forges has been exercised repeatedly and unmistakably. This is beyond any doubt.

That the Comité des Forges could make its wishes prevail is indisputable; the question therefore arises: What interest had the Comité des Forges, if any, in inducing the French government to enter and occupy the Ruhr?

The supporters of the Comité des Forges contend that the proof that it is in no wise responsible for the occupation of the Ruhr is that it is the first to suffer from it; that French metallurgy has been compelled, since the Ruhr expedition, to cease operations in the majority of its blast furnaces; that the Germans reckon upon its ruin to bring about the capitulation of the French government; that French metallurgy is in the forefront of the fight and receives the hardest blows.

This requires some explanation and correction.

There is no doubt whatever that the French metallurgy of the eastern districts has suffered from the occupation of the Ruhr, and from the lack of Ruhr coal and coke. It is a fact that the French eastern metallurgy stands in need of the Ruhr coke and finds nowhere else its equivalent; neither in England, where it is too expensive, nor in the Sarre, where quality of coal is unsuitable, and even less in north of France. Concerning the latter, it is worth recording that French metallurgy orders no coal from the coal mines of the north of France, and that the latter have declined to such a degree, since the war, that there is little likelihood of their recovery.

But though the eastern, the Lorraine, metallurgy is in "the forefront," and receives "the hardest blows," that does not mean at all that the entire French metallurgy is in a similar condition. If the Lorraine metallurgy suffers from the occupation of the Ruhr, the other firms affiliated to the Comité des Forges, for instance, those of the center of France, and, especially, the huge concern *Le Creusot,* are more fortunate. It is quite possible that a part of the metallurgical industry suffers while the whole benefits from a situation, and in this connection it is interesting to note the persistent rumors of differences and quarrels having sprung up between the various sections of the powerful association of French metallurgists.

It is even said that the industry as a whole is following a far-sighted policy, and will bear up with temporary sacrifices in view of subsequent results; that it sacrifices its "vanguard" for the sake of ensuring the final and complete victory of the main body.

It is common knowledge today that great wars are, in fact, determined by permanent causes of economic strife. The war of 1914 was due as much to economic imperialism as to political imperialism.

It is now realized that Bismarck committed in 1871 the error, from the German standpoint, of leaving the Briey district—the richest in iron ore deposits—to France, and thus jeopardized German industrial hegemony, which could be achieved only by the combined control of both the coal and iron ore. During the Great War, 1914-18, when Germany thought herself victorious, it was her metallurgists who advised the wrecking of the mines and furnaces of the north of France in order to assure final German domination.

The accusation leveled at the Comité des Forges amounts, in fact, to supposing that the plan of those who held the coal in 1914 has now been adopted by those who control the iron ore.

France owns today the richest iron deposits in existence, and, moreover, it is known that they are practically inexhaustible. Yet, without the control of sufficient coal, that wealth is unworkable. While Germany, master of the coal, could not become master of the world without owning the iron, the French, master of the iron, cannot dominate without owning the coal.

Unquestionably the French and the German industries are naturally and fatally bound to one another and interdependent. They must, as the German foreign minister, Herr von Rosenberg, said recently, live together or die together. But that solidarity cannot prevent the fact that on both sides the desire to control and command is entertained.

Before 1914, it was the German who wanted to be the "boss" of the combine. Is it so improbable that today it should be the Frenchman?

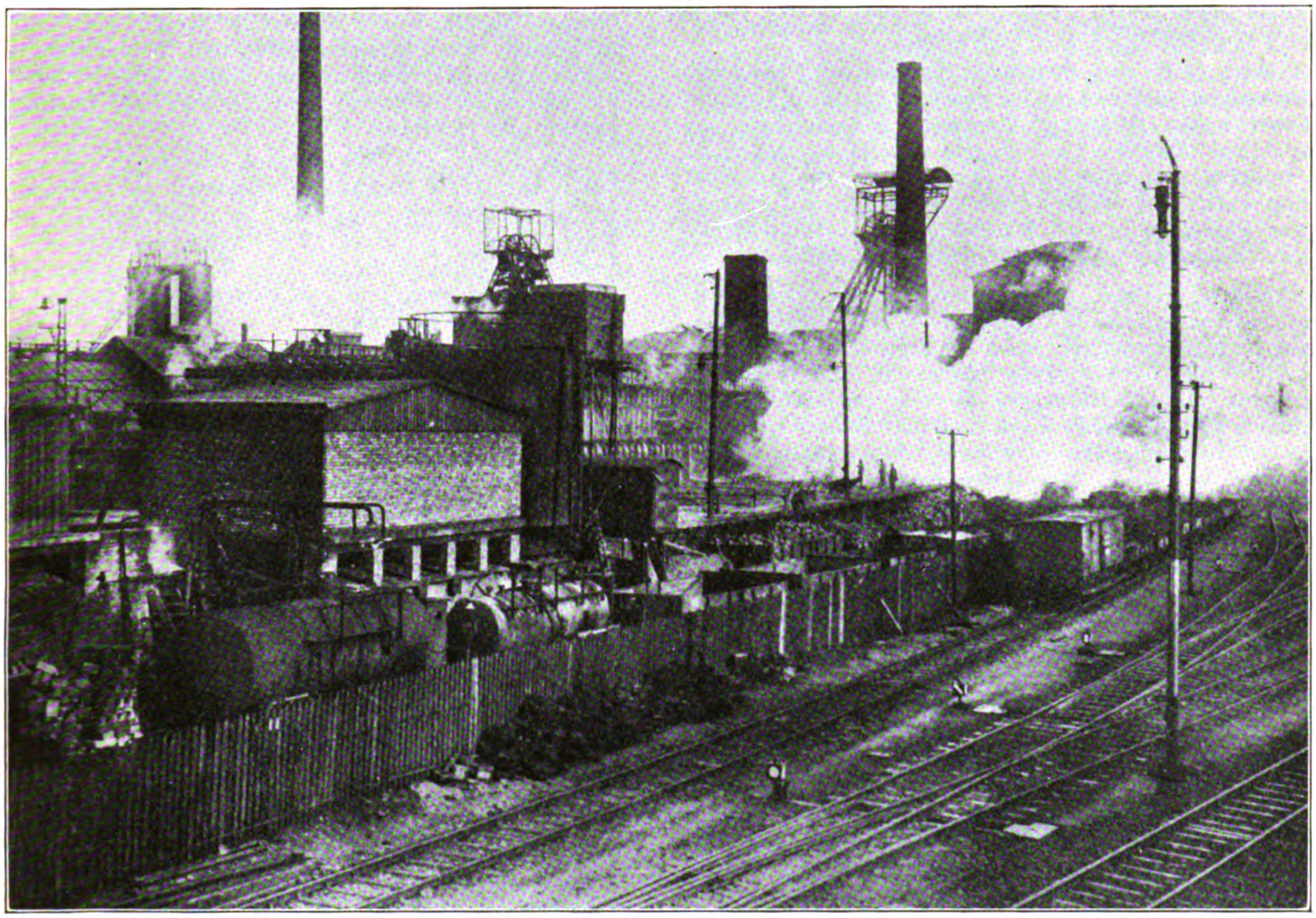
That there have been negotiations between the two heavy industries of France and Germany, is undeniable. Between the London and the Paris conference, Messrs. Stinnes, Kloeckner and Silverberg proposed an agreement whereby coal would have been exchanged for iron. The proposal was rejected. Neither the French government nor the Comité des Forges will admit any negotiation or agreement, and both insist on Germany "giving in." In short, it rather looks as if it were the intention of the French government to link the question of reparations due from one state to another with that of the collaboration of the two metallurgical industries of France and Germany.

That is both dangerous and unfair.

Dangerous because experience amply proves that it is difficult, if not impossible, to compel a nation to submit to the leadership of another concerning economic production.

Unfair, because it amounts to the placing of the diplomatic and military resources of the country at the service of private interests.

Can it be that the French government, through the intermediary of the German government, and under the pretext of reparations, is endeavoring to harness the German Schwerindustrie to the chariot of the Comité des Forges?



One of the important Ruhr steel plants taken over by the French.

For a proper understanding of the Franco-German metallurgical problem, it is necessary to recall an important phase of the Paris peace negotiations in 1919 concerning the Ruhr. The role which was then played by the American and British delegations goes a long way to explain the attitude now shown by Washington and London, and the fears they entertain concerning the ultimate object of the Franco-Belgian occupation of the Ruhr.

At the beginning of January, 1919, the Council of Ten tackled the important question of French security and of the guarantees it required. Marshal Foch had drafted on January 10, two days before the first sitting of the conference, his now famous plan for the occupation of the Rhine. At the same time M. Leon Bourgeois,

Digitized by Google Original from UNIVERSITY OF MICHIGAN

also on behalf of France, had prepared, and intended proposing before the League of Nations, a plan providing diplomatic and juridicial security—the only really peaceful and political solution mooted in France. And before the Economic Commission, Messrs. Kotz and Loucheur, equally in behalf of France, were preparing to propose a plan of so-called economic security, upon which it is necessary to lay some stress.

On February 7, 1919, the experts, under the direction of M. Loucheur, forwarded a report concerning the disarmament of Germany. They adopted the generally-recognized standpoint that modern warfare depends on economic conditions and on industrial means, and that if they wanted real security, the Allies, and France in particular, should not only disarm Germany, in the hitherto accepted sense of the word, but should render her a cripple economically and definitively.

Consequently, they demanded the control of the arms and muntions factories, and a general control of German industry in the Rhineland region by a Commission of inter-Allied officers: "a complete control by means of the military occupation of Essen and of the principal Krupp works, *and of the greater part of the coal deposits of the Rhineland and of Westphalia, and of the metallurgical industries which are dependent thereupon.*"

President Wilson, acting upon the advice of Maj. Gen. Bliss, categorically turned down these suggestions, basing his decision chiefly upon the argument, which subsequent events have so fully borne out, that if officers were sent into the Rhineland for that purpose, serious trouble would inevitably result and that it would become necessary to protect the missions by important bodies of troops.

President Wilson did not, however, absolutely reject the control of war factories, but, in accord with Mr. Lloyd George, he proposed the seizure and control by the Allies of the distribution of raw materials. (Ultimately, this would have provided a useful means of control over armaments which could have been exercised by the League of Nations.)

The French delegation, however, made fresh efforts, after February 15, 1919, during the trip President Wilson was compelled to make to the United States, and again demanded *perpetual* control of armaments and over German industry capable of being utilized for war purposes: the chemical, the aeronautical and the metallurgical industries.

On March 3, 1919, M. Clemenceau declared in the Council of Ten that he would not remain content with temporary measures and would not sign a treaty which would leave to Germany the possibility of again attacking France, *be it even after thirty or forty years*; and that, therefore, *it was necessary to weaken permanently and finally the industrial power of Germany.*

Upon his return, President Wilson again protested, at the sitting of March 17, against such a system that would entail a continuous, everlasting intervention, not only in the domain of political sovereignty, but also in that of Germany's commercial and economic freedom.

The meaning and importance of these precedents is self-evident. It is easy to understand the degree of suspicion which the French occupation of the Ruhr raised in Washington and London. The occupation of the Ruhr in 1922 appears strangely and dangerously as the resumption and the continuation of the French plan of 1919. Obviously, both Washington and London apprehend, despite semi-official, or even official denials, that the real aim pursued by France is that of crippling and finally controlling German industry.

But, beside this French national aim, there is reason to suspect that the plan of perpetual control of German industry by France, which was drafted by Messrs. Klotz and Loucheur, had at least the assent of the leading French metallurgists. Therefore the occupation of the Ruhr is, with some show of plausibility, represented in French radical circles, and abroad, as being a move in the negotiations between the French Comité des Forges and the German *Kohlensyndicat* and *Schwerindustrie* for the control of an impending Franco-German combine which will include French iron ore and German coal.

The founding of an international trust, of which the two governments would become the pliable servants and business agents, would necessarily present great difficulties, chiefly when it is considered that the partners in the combination have been as long and as bitterly separated by national resentment and feelings of hostility as France and Germany.

The Franco-German combine may be in the making, but it has still a formidable opponent to overcome in British metallurgy, which can be relied upon to oppose it by all and any means. The British industry so far is alone in profiting from the Ruhr deadlock, which enables British foundrymen and coal owners to sell metal to Germany and coal to France.

There is reliable evidence that the formation of a huge Franco-German combine, uniting French iron ore from Lorraine with German coal from Westphalia is being seriously considered. Indeed, it seems very likely that such a Franco-German combine or trust will mark the end of the protracted Franco-German antagonism which, in Clemenceaus' famous words, "since the close of hostilities, continues the war by other means."

The *Bulletin Quotidien* (Daily Bulletin), which is the recognized official mouthpiece of the Comité des Forges, recently declared outspokenly and rather bluntly:

"How could one fail to recognize that European peace will be restored on a solid basis only on the day when the present political and military peace with which we have been gratified until today, will also have become an economic peace? Since France has entered the Ruhr, much talk is heard, and with reason, of a coming Franco-German arrangement. Is it not incredible that such an arrangement could fail to include a settlement of the relations between our Lorraine metallurgy and the German coke?" And this official gazette of the Comité des Forges goes on to recommend that in the formation of such a Franco-German combine, the interests of Belgium should be safeguarded and taken care of.

A Franco-German metallurgical and coal combine would also settle for a while the question of respective rights of precedence of "politics" over "economics" and vice versa, by giving proof of their entire interdependence and complete solidarity. Moreover, it would provide a broad and solid basis for the urgently-needed economic reconstruction of Europe as a single unit, which is now recognized to be the only effective remedy for the present economic and financial distress.

The reparations problem is an international, and mostly, an European problem. It should be solved not against such or such a nation, but for Europe as a whole. And, as all durable undertakings require a broad and solid basis, a Franco-German combine of the inexhaustible wealth of Lorraine iron ore and Westphalian coal would provide such a basis of sufficient breadth and solidity to support a durable European edifice. It could determine in the Old Continent the required reconstruction activity and the necessary power of production.

The chief obstacle to the achievement of a Franco-German coal-iron combine, which would be the foundation of the economic reconstruction and organization of Europe, is Great Britain, who will never consent to it. It will, therefore, have to be achieved *against* Great Britain because in no case can it be achieved *with* her.

A close study of the tragic history of the last 15 years reveals that the real causes of the Franco-German conflict are far from being those which are usually invoked on both sides of the Rhine. They are made up of the antagonisms which are the inevitable outcome of the division of the mineral and coal deposits of the northern plain between the capitalists of the two nations.

In May, 1915, the German jingoes, aided and abetted by the "Schwerindustrie" (heavy industry) of Germany, began a fierce agitation in favor of the annexation of the French Lorraine iron ore deposits (known as the "minette" of Lorraine) as well as of the coal districts of Belgium and of the north of France. In a confidential memorandum they asserted: "The security of the German Reich in a future war peremptorily demands the possession of all the deposits of the 'minette of Lorraine,' as well as of the fortresses of Longwy and of Verdun, without which that region could not be usefully controlled."

That was the brutal avowal of German imperialism which owned that its aim was "to marry" the Lorraine iron ore with the coal of the Ruhr, of Belgium and of the north of France. It could then have dominated Europe and, maybe, the world.

Ever since the Allied victory and the Armistice of November 11, 1918, the French Comité des Forges has endeavored to obtain a sufficient and assured supply of the Westphalian coal, which is indispensable for the working of its blast furnaces.

Shortly before the entry of the Franco-Belgian troops into the Ruhr on January 11, 1923, an attempt was made to solve the problem by negotiating a Franco-German understanding for a Franco-German trust or combine, in which France would supply the iron ore and Germany the coal. The negotiations between the Comité des Forges and Stinnes and his colleagues proceeded until the all-important question of the shares to be owned by each side was reached. That was the rock which caused the wreck of the entire agreement. The Comité des Forges claimed control and hegemony with 60 per cent of the shares, while Herr Hugo Stinnes and his colleagues refused any arrangment other than absolute equality, that is, a "fifty-fifty" arrangement. The preceding facts were admitted by Hugo Stinnes himself in the *Rheinische-Westfalische Zeitung* of January 21, 1923.

The radical opponents of M. Poincaire's government assert that reparations and security are only a convenient veil and an excuse for exercising French military pressure, not on Germany as a nation so much as on the Schwerindustrie of Germany, and not so much in the interest of France as that of the French Comité des Forges. This is energetically denied by the Poincaire government.

However that may be, the Ruhr conflict is proving ruinous for both countries, and the victory of either party would be equally threatening for the peace of Europe and of the world. If Germany should win, the result of the war of 1914-18 would be endangered, if not actually reversed, and in fact the Versailles treaty would be torn to pieces. If France wins, her victory will prepare a formidable conflict between France, whose metallurgy would become dominant by her control of the Ruhr coal, and Great Britain, which would never consent to the threat or even to the possibility of French hegemony over Europe. France having already the strongest army and the most powerful aviation forces, the "marriage" of her Lorraine iron ore ("minette") with the Ruhr coal, under her control, would inevitably bring her into conflict with Great Britain. Such a conflict would be infinitely fiercer and more destructive than that of 1914-18, and would probably achieve the utter ruin of European civilization. Therefore, by all means, it must be avoided.

On April 21, 1920, a limited liability company called "L'Union Européenne Industrielle et Financiére" was founded in France. Its avowed aim was the undertaking of all kinds of industrial, commercial, financial and agricultural business; but its special purpose was the revival and the continuation of the shareholdings and the interests owned by Messrs. Schneider & Cie (the huge metallurgical firm of "Le Creusot") and by the Banque Parisienne, in the following Central European undertakings which they now control:

The Skoda Works (foundry, iron and steel works).

Société des Establissements Réunis (mechanical construction).

Osterreichische Berg and Huttenwerks Gesellschaft (collieries, iron ore mines, blast furnaces).

Société des Forges et Aciéries de Hutta Bankova (Poland).

The capital of the Union Européenne was 75,000,000 francs at the start. Its directors are:

M. V. Champigneul, who is also of the Société d'outillage mécanique, et usinage d'artillerie, usually referred to as the S. O. M. U. A.

M. Fournier, of the same firm and also of the Schneider firm and others.

M. L. Lion, director of the Société Francaise de construction mécanique.

M. F. Mallet, director of the Chantiers de la Loire, of the Banque de l'Union Parisienne, of the Banque nationale francaise de commerce extérieur.

M. J.-F. de Neuflize, director of the Banque hypothécaire d'Espagne, of the Banque Ottomane, of the Banque franco-argentine, and of the Schneider firm.

M. E. Schneider, of the Creusot, director of the Ateliers de la Gironde, of the Crédit Lyonnais, etc.

M. Ch. Schneider, of the Schneider firm.

The firms upon whose boards the above sit as directors are firms turning out war material. The S. O. M. U. A. (Société d'outillage mécanique et usinage d'artillerie) manufactures all kinds of war material for both the army and the navy, and its chairman is M. E. Schneider. The Chantiers de la Loire work for naval construction; the chairman is M. F. Mallet. The Ateliers de la Gironde are concerned with naval construction, repairs and armament; the chairman is M. E. Schneider.

Out of nine directors of the Union Européenne, four belong to the Schneider firm (Le Cruesot), and it is therefore an undertaking controlled by Le Creusot, which is the leading French armament firm. The Union Européenne is affiliated to the most powerful French banks by the Crédit Lyonnais with M. E. Schneider, and by M. Mallet and M. Neuflize, who head well known dynasties of bankers. The Union Européenne is also backed by the Société Génerale, the Comptoir d'Escompte and the Banque de l'Union Parisienne, upon the board of which latter M. E. Schneider of Le Creusot sits alongside of M. Francois Marsal, the former finance minister of the Millerand government. The Union Europeéne is, in fact, the most powerful financial and industrial group in Central Europe. It centralizes the management of the most important control over all the important financial and industrial concerns of Central Europe. Facing the French group is the German competition, led by Hugo Stinnes, who, in March, 1921, outbid it and purchased from the Italian firm Fiat its holding in the Alpin Monton Gesellschaft, which is a great metallurgical firm of Austria owning iron-ore mines and 12 blast furnaces, besides coal mines in Czecho-Slovakia.

That is one important phase of the Franco-German metallurgical antagonism, and one of the main causes of British suspicion of French intentions, and of British alarm at the possibility of French European hegemony.

The only possible permanent solution of the Franco-German antagonism is that of an economic agreement. In the present circumstances it naturally sounds rather improbable and most difficult, yet the recent events which render such a solution difficult to the point of improbability at the same time confirm the view that such a Franco-German economic entente is indispensable if Europe is to be spared utter ruin. If that obviously desirable end is ever to be achieved, the tone of the press of both countries must change and must favor it. Agreement and co-operation must succeed all the talk of "Kraftprobe" (test of strength), as the Germans put it. The press of both countries must cease encouraging the struggle between the two great nations, two laborious and courageous peoples, both of whom must be reckoned among the most important pillars of civilization.

Some comments on the Ruhr struggle remind one of a sensational boxing contest wherein the moves of each contestant are loudly cheered by the partisans witnessing the contest. But the Ruhr is no sporting contest, for it can bring no victory to either side. It is disastrous for Germany, which is cut off from its wealthiest and most important industrial center, and is faced by the terrible choice between unemployment or costly recourse to supplies of British coal and of Spanish and Swedish iron ore. It is disastrous for France and for Belgium, which have recovered neither cash nor coal from their costly occupation of the Ruhr. It is disastrous even for the outsiders like the neighboring Swiss and Dutch, who suffer from the disorganization of their transport, and whose transport workers are thrown out of employment; and like Italy, which receives no more reparation coal and is compelled to submit to the high prices of the British coal merchants.

The remedy is the substituting of agreement and co-operation instead of the exhausting struggle.

The common interests of Lorraine and Westphalia ought to provide the basis of the agreement. Lorraine, since the return to France of the provinces lost by her in 1870, makes of France the greatest producer of iron ore in Europe. One hundred and thirty blast furnaces and numerous factories of France are waiting for the necessary coal which would enable them to turn out 7,000,000 tons of cast iron and 5,000,000 tons of steel. But if France lacks coal, Germany, her neighbor, possesses it in great plenty, while, on the contrary, lacking iron ore. The result is easy to guess; the Lorraine iron ore must, with the cast iron and the half-products of the valley of the Moselle, take again the road of the Rhenish and Westphalian furnaces, as in 1913. The first step towards it has already been taken. In the first half of 1922, over a million tons of French iron ore crossed the frontier, in exchange for a quantity of industrial coke sufficient to satisfy the requirements of three-quarters of the Lorraine coke consumption. Moreover, the French Comité des Forges, which had been working only to 40 per cent of its capacity, was enabled to increase that figure, thanks to the increased sales to the German iron masters.

Economically, the case for a Franco-German understanding is proven beyond the possibility of doubt or of dispute.

There remains the important work of putting a stop on both sides to the stirring up of hatred. The gap to be bridged between the two peoples is very wide and deep, and the first step should be ceasing to dig it deeper and wider as is unfortunately being done at present.

WORLD TRADE IN STEEL RAILS

(Continued from page 383.)

Ceylon	8,583	2,434	6,144	11,055	10,307
Straits Settlements	4,973	266	727	225	‡
Sweden	1,265	5,391	14,616	340	1
Other countries..	80,840	54,551	53,038	33,397	§85,167
Total	464,250	125,218	130,743	177,101	255,770

---

* Exclusive of tram rails with grooved heads.

† Total exports to British Africa, of which exports to Cape of Good Hope and Natal formed 98 per cent in 1921.

‡ Not reported separately.

§ Including any exports to Brazil and Straits Settlements and excluding any exports to parts of British South Africa other than Cape of Good Hope and Natal.

largest customer and 1922 purchases were in excess of the prewar average, representing over two-fifths of total British exports as compared with less than a fourth in the prewar years. Ceylon is the only other country enumerated which showed an increase in 1922 over the prewar years. Exports to Argentina in 1922 were one-eighth of the prewar average. British possessions account for the bulk of the rail exports of the country.

TABLE C — EXPORTS OF STEEL RAILS FROM THE UNITED STATES

Country	*1910-14 (5-yr. aver.)	†1919	†1920	†1921	†1922
			(In gross tons)		
Canada	87,830	25,580	15,658	23,032	23.294
Argentina	42,773	855	17,107	11,182	2,854
Australia	40,790	23	237	2,603	‡
Mexico	37,458	10,670	8,801	5,005	13,034
Brazil	34,795	8,816	50,982	21,690	4,345
Cuba	33,972	57,281	114,371	19,366	28.054
Japan	31,552	152,997	135,873	42,072	133,134
Chile	17,140	11,146	8,135	6,641	4,888
Philippine Islands	9,366	13,997	21,938	6,649	7,738
China	6,033	23,320	13,766	45,732	4,392
Honduras	3,308	6,336	10,840	12,951	7,489
British South Africa	1,835	23,817	22,482	1,410	‡
United Kingdom.	1,535	9,161	14,859	14,384	2,036
Dutch East Indies	85	29,536	37,719	32,364	....
British India	21	4,279	4,918	3,411	‡
Other countries..	45,449	274,629	116,942	73,330	§47,834
Total	393,942	652,443	594.628	321,822	279.092

---

* Fiscal years ending June 30.

† Calendar year.

‡ Not reported separately.

§ Including any exports to Australia, British South Africa and British India.

Heat Balance of Carbonization Process

As Carried Out in By-Product Ovens, with Special Reference to Data Published in the Gas Age Record of February 17, 1923.

By JULIUS K. MUNSTER*

BEFORE presenting the subject proper, it will be necessary to state certain fundamental principles and scientific terms, in order to clear up misunderstandings, namely:

(1) An exothermic transformation is one that evolves sensible heat; an endothermic transformation is one that absorbs sensible heat. The transformation of coke into producer gas is an exothermic process, by which some of the latent heat of combustion in the coke is liberated and converted into sensible heat. The generation of steam is an endothermic process, by which sensible heat is changed into latent heat of vaporization. These two processes are carried out jointly in industry when gas producers are equipped with waste heat boilers.

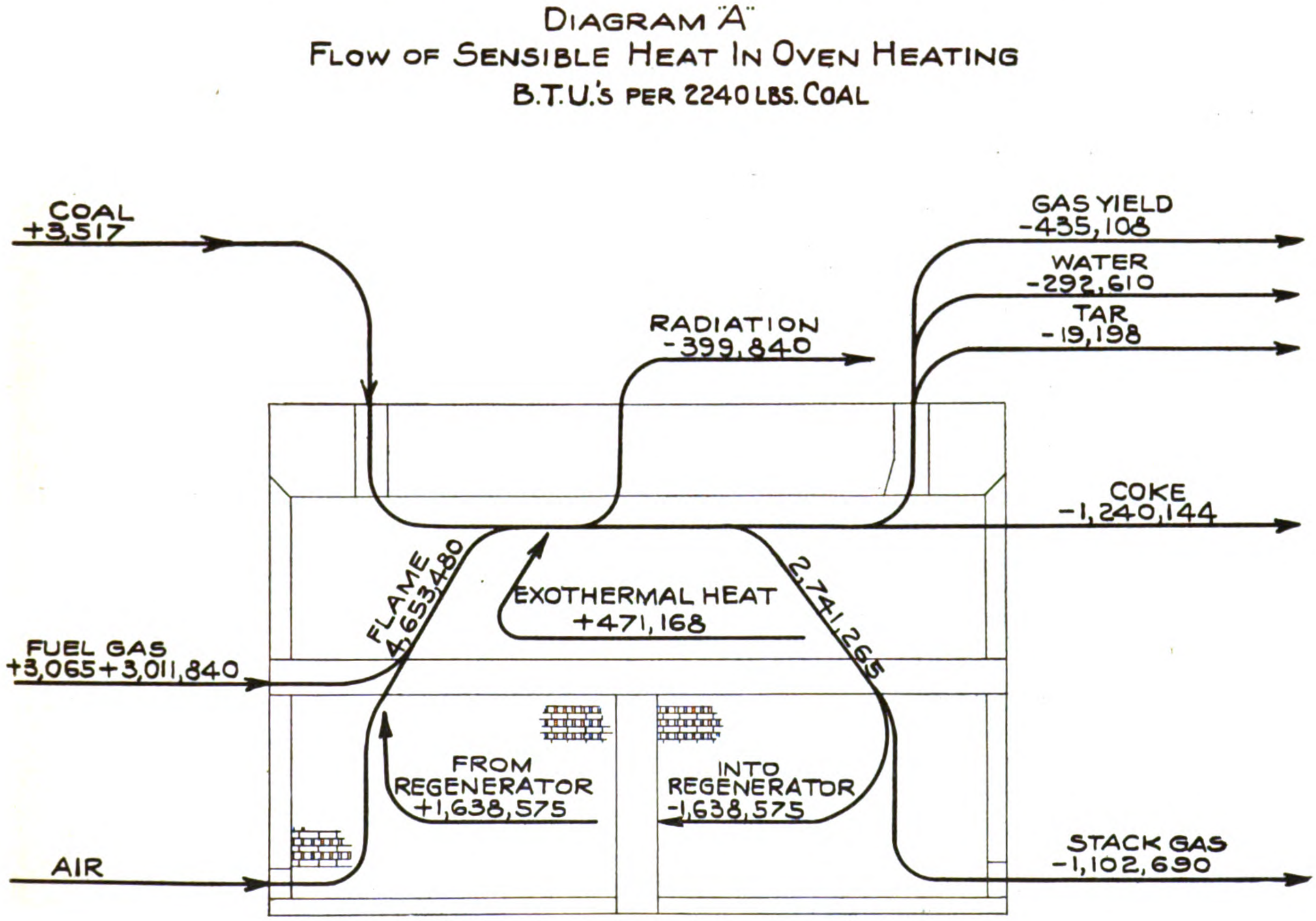


FIG. 1—*Flow of sensible heat in oven heating, in terms of coal.*

(2) All the heat before a transformation equals all the heat after the transformation, in accordance with the law of energy.† Thus, in making a heat balance of an industrial process involving a number of exothermic and endothermic changes, if all forms of heat, latent and sensible, are accounted for, there will result perfect equality between the sum total of heat items before transformation and that after. For instance, if the transformation of one combusible material into another is attended by the liberation of heat as in the producer gas process just mentioned, the resultant material will contain less latent heat of combustion than the original, exactly to the extent that sensible heat has been evolved. However, if latent heats only, or sensible heats only, are considered in making the heat account, there will as a rule be a difference between the sum of heat items before and that after transformation, indicating to what extent the process is either exo- or endo-thermic. For example, Constam and Kolbe, taking into consideration only latent heats of combustion before and after the carbonization of coal,

---

*Research Engineer, the Koppers Company, Pittsburgh, Pa.

†Unless some other form of energy than thermal is generated, which is evidently not the case here.

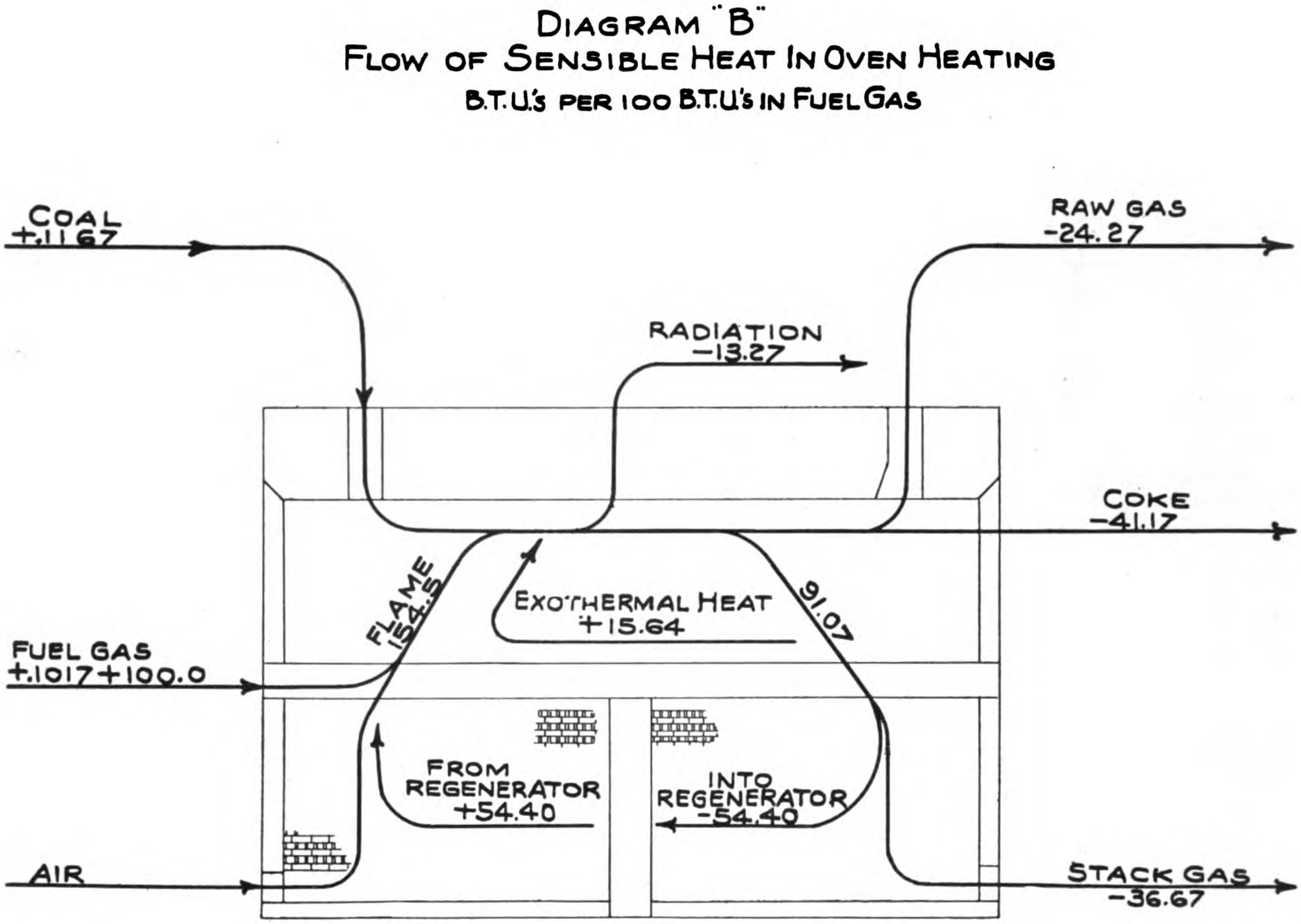


FIG. 2—*Flow of sensible heat in oven heating, in terms of gas.*

found that there was 2.1 to 6.0 per cent less in all the products of carbonization than there was originally in the coal, which difference expresses the extent to which the transformation is exothermic. Lewes found the difference to be 2.5 to 4.0 per cent.

The fundamental principles having been stated, namely, (1) that an exothermic transformation is one by which sensible heat is liberated at the expense of latent heat, and (2) that all the heat before a transformation equals all the heat after the transformation, the presentation and discussion of the heat balance of the by-product coke oven process will be undertaken.

The data used for the purpose are those carefully obtained by Messrs. D. S. Chamberlin and E. W. McGovern, and published in the *Gas Age-Record,* No. 7, 1923, with reference to a well operated battery of 106 Koppers coke ovens of the Bethlehem Steel Company, run on oven gas. Before using these data, however, it is essential to ascertain whether they are attended by a perfect balance of materials in order that, whatever the heat balance turns out to be, it cannot be attacked on the ground that the materials involved were not well accounted for.

Table I shows that, as far as carbonization proper is concerned, the materials are very well accounted for, since the weights of:

Moisture + Coal = Gas + Tar + H_2O Vapor + Coke

TABLE I

BALANCE OF MATERIALS IN CARBONIZATION PROPER

Per 2240 lbs. Dry Coal

	Lbs.
INITIAL MATERIALS	
Coal	2240
Moisture	67.2*
Total	2307.2
FINAL PRODUCTS	
Coke	1645.0
Gas yield	405.6†
Tar	84.2
Water in raw gas	173.8‡
Total	2308.6

Calculation pertaining to the above table:

* Moisture: $\frac{3}{100}\,2240 = 67.2$

† Weight of gas: 13,000 cu. ft. $\times\ 0.409\,\frac{.08072}{1.058} = 405.6$

‡ Water in raw gas, originating in 3 per cent moisture and in 4.74 per cent water from the constitution of the coal: 67.2 + $\left\{\frac{4.74}{100-4.74}\,2240\right\} = 173.8$

Item (‡) does not appear in the data of Chamberlin and McGovern, but was supplemented by the writer.

As regards the materials engaged in the heating phase of the process, the figures for the weight of fuel gas and of air were derived from the quoted data and accepted as correct, while that for stack gas was obtained by simply adding the two: Fuel Gas + Air = Stack Gas. So

Digitized by Google Original from UNIVERSITY OF MICHIGAN

there can be no question of lack of perfect balance in the materials entering this phase, which could interfere with the accuracy of the heat balance.

TABLE II

BALANCE OF MATERIALS IN COMBUSTION FOR OVEN HEATING

Per 2240 lbs. Dry Coal + 3 per cent Moisture

Initial Materials		Lbs.
Fuel gas	5,792 cu. ft. $\times \frac{.08072}{1.058} \times .409 =$	181.5
Air	39,501 cu. ft. $\times \frac{.08072}{1.058} \times 1 =$	3255.6
Final Product		
Stack gas	$=$	3437.1

The heat balance itself will now be presented in Table III. It represents the total carbonization process, carbonization proper and heating phase combined, and takes into consideration both sensible heats and latent heats of combustion. It shows a most satisfactory equality between the total sensible and latent heats in the initial materials on the one hand, and those in the final products, on the other; this was to have been expected from Principle 2. The small difference of less than 0.3 per cent can without scruple be called experimental and calculative error.

For the sake of analysis, it is proposed to deal with the combustion of the fuel gas alone, detached from the consolidated balance of Table III. The data concerned are collected in Table IV.

TABLE IV

HEAT BALANCE OF COMBUSTION FOR OVEN HEATING

Per 2240 lbs. Coal

Sensible Heat Introduced	
By coal	3,517
By air	...
By fuel gas	3,065
By combustion of fuel gas	3,011,840
Total	3,018,422
Sensible Heat in Products	
In coke	1,240,144
In gas yield	435,108
In water vapor	292,610
In tar	19,198
In stack gas	1,102,690
Iu radiation and convection	399,840
Total	3,489,590

From Table IV it can be seen that the sensible heat in the total final products is greater by 471,168 Btu. per gross ton than that contained in and liberated by the fuel gas and air. This increase could have been due only to the carbonization process proper. The carbonization process is therefore exothermic, according to the definition of that term in Principle 1, to the extent of

$$\frac{3,489,590 - 3,018,422}{2240} = \frac{471,168}{2240} = 210 \text{ Btu. per lb.}$$

coal, or $100 \times \frac{471,168}{30,369,920} = 1.55$ per cent of the total latent heat of combustion in the coal.

The latter figure is only 0.5 per cent below the lower

TABLE III

HEAT BALANCE OF CARBONIZATION PROCESS, INCLUDING COMBUSTION FOR OVEN HEATING

For More Complete Information, Quantities and Temperatures Are Given

Sensible heats and latent heats of combustion in initial materials	*Quantity*	*Temperature deg. F.*	*Btu. per 2240 lbs. Dry Coal*	*Btu. per 100 Btu. in Coal*
Latent heat in coal	2240			
3 per cent moisture	67.2 lbs.		30,369,920	100.00
Sensible heat in coal	" "	70-65	3,517	.01
Latent heat in fuel gas	5,792 cu. ft.		3,011,840	10.01
Sensible heat in fuel gas	" "	89-65	3,065	.01
Sensible heat in air on entering	39,501 cu. ft.	65-65	0	0.00
Sensible heat drawn by air from regenerator	" "	2,000-65	1,638,575	5.39
Total			35,026,517	115.42
Sensible heats and latent heats of combustion in products				
Latent heat in coke	1,645 lbs.		21,575,175	71.04
Sensible heat in coke	" "	2,000-65	1,240,144	4.08
Latent heat in gas yield	13,000 cu. ft.		6,760,000	22.26
Sensible heat in gas yield	" "	1,200-65	435,108	1.43
Sensible heat in water vapor carried by gas	173.8 lbs.	1,200-65	292,610	0.96
Latent heat in tar (including heat absorbed in tar formation)	84.2 lbs.		1,347,200	4.43
Sensible heat in tar	" "	1,200-65	19,198	.06
Latent heat in light oils	2.33 gals.		300,037	.99
Sensible heat deposited by stack gas into regenerator)	5,100.5 lbs.	2,200-650	1,638,575	5.39
Sensible heat discharged by stack gas	" "	650-65	1,102,690	3.63
Sensible heat lost by radiation and convection			399,840	1.32
Total			35,109,577	115.59

limit of that of Constam and Kolbe, found by calorimeter. It corresponds very nicely, considering the complex nature and multitude of measurements underlying the data here employed.

The separate heat balance of fuel gas combustion can well be used for the presentation of a heat flow diagram, inviting an analysis of the heating operation in general. Two diagrams are given, "A" referring to 2240 lbs. coal carbonized and embodying the figures of Table IV, "B" in percentage of the heat liberated by the fuel gas. The diagrams are self-explanatory, but it may be well to bring out a point of peculiar interest, the function of the regenerators. Each pair of regenerators acts as a storeroom, from which the incoming air draws a certain amount of heat, and into which the outgoing stack gas deposits an equal amount of heat. This means that the air does not introduce heat into the process from outside, and should not be credited with doing so, in making a heat balance; but if one desires to take into account the regenerative heat, this should be done in such a way as not to affect the equality of the balance, namely, entered on the incoming side as heat withdrawn from the regenerators by the air, and on the outgoing side as heat deposited into the regenerators by the stack gas; this was done in Table III. The regenerative heat taken up by the air joins the main current at the point of flame formation, very effectively elevates the temperature there, and thus accelerates the penetration of heat into the oven chamber.

With reference to the discharge side of the heat flow diagrams, it is evident that there are three large items of heat quantities which ultimately are dissipated—the heat of coke into the quenching water, the heat of raw gas into the primary coolers, and the heat of stack gas into the air. These items are 41.17, 24.47, and 36.67 per cent, respectively, of the heat liberated by the fuel gas. They all tempt the heat economist to find ways of recovering them for useful purposes. For instance, as regards the heat of coke, Schlemming in Bonn aimed to generate water gas while cooling the coke with steam. Sulzers in Winterthur proposed a different way, to cool the coke in a temporary container, by means of stack gas which is cooled by a waste heat boiler and kept circulating between hot coke and boiler by a ventilator; an installation of this kind on a commercial scale is reported to have resulted in the production of 400 weight steam per 1,000 weight coke quenched, the glowing coke being cooled down to 480 deg. F. (See Gas und Wasserfach, 1921, page 204.) A third way of recovering the heat from the hot coke, which is used at some places where the carbonizing installation is a gas plant also equipped with water-gas sets, is to charge the glowing coke into the water-gas generators. With regard to the heat contained in the raw gas as it leaves the ovens by the standpipes, no application has yet been found. Concerning the waste heat in the stack gas, it may be said that the temperature of the stack gas is so close to that necessary for producing the stack draft, that its further cooling does not seem practicable.

This article will now be concluded with the remark that it gives the correct interpretation to an unusually complete set of data relating to large scale coking operations, which will be a good source of information to those interested in strictly quantitative aspects. The correctness is proven by the fact that materials as well as total heats, before and after transformation, balance; and further by the fact that the account harmonizes with the conclusion drawn from calorimeter tests showing the exothermic nature of coal carbonization.

The Vicious Cycle

The Position of Steel Prices in Comparison With Other Basic Materials, Indicated a Rising Tendency. The Inevitable Wage Advance Announced April 16 by the Leading Factor Was Quickly Followed by All Leading Interests—Steel Prices and Wages Were Out of Line.

The inevitable wage advances in the metal working industries have brought along in their wake the much predicted and expected reaction.

Unfilled steel tonnage reports showed a falling off for the month of April. This is the first reduction in volume this year. Volumes are more important than prices, for prices follow volumes.

The indirect effect of an increase in steel wages upon the prices of steel and other commodities was indicated by the course of the Bradstreet price index following the marking up of steel pay scales last September. On August 1, this number stood at $12.0688, and by October 1, it had jumped to $12.5039.

The following table shows the wages of common labor after each increase or decrease in wages by the United States Steel Corporation, the percentage of each advance or decrease, and the cumulative percentage of each advance or decrease over the rates paid in 1915:

-	Wages 10 hours.	Pct. Advance.	Advance Over 15 rate.
1915	$ 2.00	....	....
February 1, 1916	2.20	10	10
May 1, 1916	2.50	13.6	25
December 15, 1916	2.75	10	37.5
May 1, 1917	3.00	9	50
October 1, 1917	3.30	10	65
April 16, 1918	3.80	15	90
August 1, 1918	4.20	10.5	110
October 1, 1918	*4.62	10	131
February 1, 1920	5.06	10	153
May 16, 1921	†4.05	†‡20	‡103
July 16, 1921	§†3.70	‡8.5	85
August 29, 1921	3.00	‡¶20	50
September 1, 1922	3.60	20	80
April 16, 1923	4.00	11	100

---

*Eight hour basic day established and time and one-half paid for overtime.

†Approximated.

‡Decrease.

¶Time and one-half abolished.

§Decrease.

Naval Officers Receive Degrees

Lieutenants Gilbert C. Hoover and John H. Keefe, of the United States Navy, were awarded degrees of Bachelor of Science in Metallurgical Engineering last June at Carnegie Institute of Technology, in Pittsburgh. These two naval officers were the first to complete a year of special study in metallurgical engineering since Carnegie Tech was selected by the U. S. Naval Academy about a year ago as the institution to which it proposes to send its graduates for specialized training in metallurgy.

During the past year, Carnegie Tech has concentrated much attention upon its metallurgical engineering courses, with the result that an advisory board consisting of executives and engineers in big metallurgical plants in the district has been organized to co-operate. An expected development of the organization of the advisory board, says an announcement, will be closer unity of the metallurgical industries and the Institution, not only in the specialized training of students but in various research undertakings.

THE SAFETY CRUSADE

Maintenance of Men

This Is of Greater Importance Than Maintenance of Machinery. Sanitation and Drinking Water All-Important.

W. T. FILMER, of the Youngstown Sheet & Tube Company, has a very timely description of this feature of Welfare and Safety as emphasized in the June Bulletin:

Not the least important, in the factors of the design of a modern industrial plant, are those factors which involve the health and strength of the employes.

In order that the employes of the various works might have the full benefit of the best facilities available, the officials of the Youngstown Sheet & Tube Company several years ago directed that an intensive study be made of the sanitary conditions in order to determine what more could be done to produce as nearly ideal conditions as was possible.

The problem involved both latrine and lavatory equipment. It is essential that latrines should be located at no very great distance from the place where the men work. This for two reasons: First, for the convenience of the men, and, second, in order to avoid any unnecessary loss of time from work.

The type of equipment for latrines was selected to insure continuous operation. More artistic appearing equipment might have been provided, but such equipment is more important in service than it is in appearance, so that the appearance was sacrificed to serviceability. All departments of the East Youngstown plant and the plants at Struthers have been provided with full and complete latrine facilities, except in a few scattered instances where all the details of the program have not been carried out.

The location of lavatories requires that they be placed where sufficient light and air are available.

The equipment for the lavatories brought up the question of drying facilities for clothing worn in the mills. In many cases the clothing is thoroughly saturated with perspiration at the end of a turn, and it becomes necessary that it be hung so as to permit it to dry. To place such clothing in lockers would result in its becoming mildewed, so the overhead hanger system was adopted. This system has worked out very well. Each employe having the key to his own hanger gives a reasonable insurance against theft and at the same time permits a free current of air to pass through the clothing and permit it to dry. The floor space is left open and clear, giving ample space for dressing. The washing facilities in the lavatories include shower baths and wash bowls in sufficient numbers to take care of the peak requirements.

Recognizing the possibilities of considerable personal loss on the part of the employes in case of fire, the buildings are generally built fire proof; where they are not completely fireproof, the risk is so small as to make them practically so.

Buildings of this type have been built at the Puddle Mills, Sheet Mills, Merchant Mills and Converting Mills, and the second story of the Pump House at the Coke Plant has been similarly equipped. Other buildings are projected for the Blast Furnaces, Open Hearth, Blooming Mills and Tube Mills, all of which will be built just as soon as conditions will permit.

Drinking Water System.

The intimate connection existing between the water we drink and the health we enjoy is too well known to require any argument here.

In industries where the working conditions are such that employes perspire very freely, such as a steel mill, an adequate supply of water of bacteriological purity and proper temperature is essential, if efficiency and health are to be maintained. There is no argument, of course, about the bacteriological feature. Any water which shows any suspicion of dangerous bacteria is, of course, unfit for human consumption. There is, however, too much ignorance of the question of temperature; it is better to drink water a little warm than too cold. To be sure, it is more palatable if it is cold, but it is far more injurious if it is too cold than if it is not cold enough to be enjoyable Fortunately, there is a range of temperature which is both palatable and beneficial. If water can be taken into the human body between 50 and 55 degrees, it fulfills both of these requirements. This temperature was used as the basis of the design of our drinking water system, together with the requirement of three gallons per man in 12 hours. The water is subject to daily bacterial analysis, and is cooled by refrigerating machines located in closed cooling stations.

After being cooled, the water is pumped through insulated pipes, usually not more than 2,000 feet of pipe between the stations, discharging into another refrigerating machine, where it is again cooled and pumped into another 2,000 feet of pipe, and so on, back to the original machine. Fresh water is admitted at each of these cooling stations to make up for water which is used between the stations.

About 25,000 gallons of water per day are required for the East Youngstown plant, this being the amount actually required for drinking purposes, in addition to the water required for condensing purposes at the refrigerating machines.

In some parts of the plant, drinking water is provided directly from wells. When good dependable wells are available, we endeavor to use them as long as possible, but when the supply becomes insufficient, or shows the slightest evidence of pollution, the well is abandoned, and a cooling and circulating system becomes necessary.

We have endeavored to provide equipment for the comfort and well-being of our employes on the basis of what is necessary in order to accomplish the best results, recognizing the fact that the maintenance of men is of more importance than the maintenance of machinery.

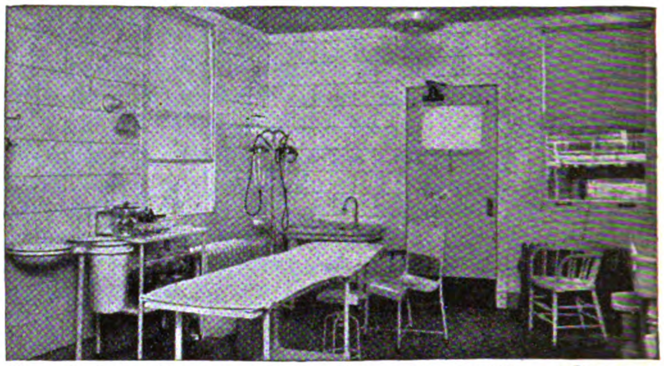
EMERGENCY AND BASE HOSPITALS

Tennessee Coal, Iron and Railroad Company Hospital, Fairfield, Alabama

Illinois Steel Company Hospital, Gary, Indiana

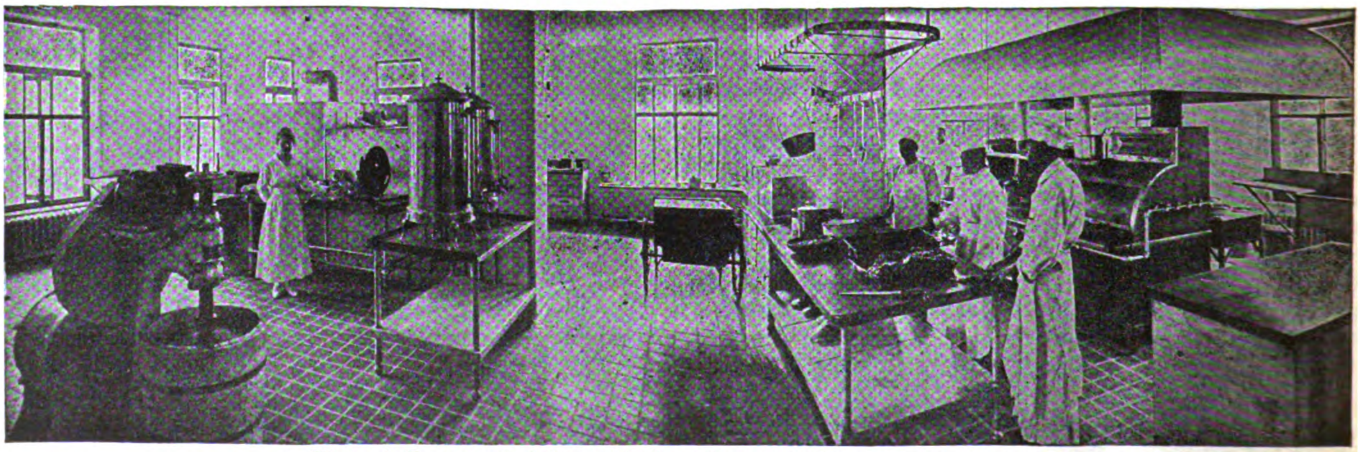
Oliver Iron Mining Company Hospital Hibbing, Minnesota

Regional First Aid Contest Held at Leisenring No. 1 Mine H. C. Frick Coke Company


Operating Room, Emergency Hospital, Universal Portland Cement Company Buffington Works

United States Coal and Coke Company Hospital, Lynch, Kentucky

Emergency Hospital, Carnegie Steel Company, Duquesne Works


Kitchen in Tennessee Coal, Iron and Railroad Company Hospital, Fairfield, Alabama

Typical methods employed by various organizations to further the Safety and Welfare Campaign.

CURRENT TECHNICAL DIGEST

Late Patents—American, British, Foreign

Coating of Metals. No. 182,988, British. W. B. Brunskill, Cark-in-Cartmel, Lancs.

A rust-preventing coating is deposited on iron or steel articles by immersing the articles in a boiling solution of mono-metallic zinc orthophosphate, in contact with metallic zinc, contact with iron being prevented. The coating consists mainly of metallic zinc, the formation of iron phosphate being minimized, and, as far as possible, obviated. The iron or steel article may be suspended in the phosphate solution by a zinc strip or hook, and may be loosely enwrapped in the supporting device or may have zinc strips loosely twisted about it; or it may be carried in a perforated zinc tray or wire basket, or clipped to a perforated zinc plate. The solution is contained in a zinc or galvanized iron tank, and to the solution may be added sufficient finely-divided zinc to impregnate the whole solution when boiling. After treatment in the tank, the article is washed to remove any loose deposit of iron phosphate, and allowed to dry.

Welding Torch. No. 1,432,528, American. John B. Burdett, Glencoe, Ill.

A one-piece nozzle having one longitudinal central perforation through which the gas is delivered to the burning tip and means within the nozzle more than half the nozzle length from the burning tip delivering to said main perforation two streams of mixed gas, there being also provided means wholly within the nozzle itself adjacent to the intake end for forming each of said streams of mixed gas out of two component gases.

Automatic Fuel Saver. No. 1,432,610, American. Carl A. Norall, Los Angeles, Cal.

An automatic fuel regulator comprising a case having fuel inlet and outlet chambers, an aperture between the chambers, a valve seat formed in the wall of said aperture, a rod having a slideable contact with the aperture, a by-pass in said rod adapted to allow communication between the chambers when the rod is shifted so that a portion of the by-pass is within each of the chambers, and a valve arranged on the rod to repose in said seat and close said aperture when the by-pass is in non-communicative position with respect to both of the chambers.

Acid-proof Casting. No. 1,432,923, American. Henri and Levy Terrisse, Marcel, Geneva, Switzerland.

An acid-proof casting which has great mechanical and chemical resistance made from an alloy containing iron, silicon, and tungsten, and which contains from 10 to 30 per cent silicon, and from 2 to 20 per cent tungsten.

Regulator. No. 1,433,416, American. Ira M. Reid, Williamstown, W. Va.

A pressure regulator having a cut-off valve seatable in the direction of supply pressure, a plunger carried by a pressure actuated diaphragm, means actuated by the plunger for normally retaining the cut-off valve in an unseated position, and trip mechanism actuable by valve unseating movement of the plunger for releasing the cut-off valve.

Construction of Coke Oven Wall. No. 1,433,450, American. Joseph Geiger, Steelton, Pa.

In coke oven wall construction, spaced inner and outer tiers of bricks arranged in courses, and flue bricks disposed between the courses and each provided with an opening with ribs for engagement with the abutting ends of the first mentioned bricks, the said ends of the first mentioned bricks being rabbetted to receive the ribs.

Riveting Machine. No. 1,433,953, American. William H. Kennedy, Chicago.

A machine comprising relatively stationary and movable jaws, a driving element, an operative connection between said driving element and said movable jaw, means for automatically disconnecting said driving element upon each cycle of operation of the machine, said means comprising a clutch and a rotable cam member to shift said clutch, and means on one of the parts driven by said driving element for automatically rotating said cam member for shifting said clutch upon each cycle of operation of the machine.

Kiln. No. 1,434,023, American. Frederick Peiter, Brooklyn.

On a rotary kiln, a main housing providing a drum chamber in its upper portion, a kiln drum mounted to extend through and rotate in said drum chamber, a fire-box in the lower portion of said housing, a horizontal partition member separating said fire-box and combustion chamber from said drum chamber, said partition member having a port beneath the receiving end of said kiln drum affording commmunication between the forward ends of said combustion chamber and said drum chamber.

Vacuum Pump. No. 1,434,851, American. Homer Clyde Snook, South Orange, and Oliver E. Buckley, Maplewood, N. J.

An auxiliary pump adapted to co-operate with a roughing pump for exhausting to low pressures comprising a chamber connected to the roughing pump and to the vessel to be exhausted, and means for producing puffs of vapor and causing them to transverse said chamber, whereby gas diffusing into said chamber from the vessel to be exhausted will be driven towards the roughing pump.

Hot-Blast Stove. No. 1,434,878, American. Ambrose N. Diehl, Duquesne, Pa.

The combination with a hot-blast stove having the usual outer wall, central combustion chamber and intermediate checker-work, of means spaced above and independent of said checker-work for directing the flow of products of combustion from said combustion chamber, said means being adapted to effect a substantially even distribution of the products of combustion within the passages of said checker-work.

Apparatus for Electric Welding. No. 1,434,751, American. Frederick S. Stearns, Swampscott, Mass.

A contact roll for a tube welding machine comprising two roll sections rigidly connected together, but insulated from each other, the peripheral portion of each section constituting a contact member and being detachable secured thereto by means which permits its ready removal.

Machine for Electric Spot-Welding. No. 1,435,812, American. Frank M. Cushing and William L. B. Cushing, Los Angeles, Cal.

A spot-welding apparatus comprising a frame, chambers carried upon the frame and having offset portions extending into juxtaposition, means to produce a circulation of a cooling medium within the chambers, electrode holders passing through the chambers in contact with the cooling medium, and electrodes carried by the holders at points adjacent the offsets of the chambers.

Device for Liquid Fuel Vaporizing. No. 1,436,099, American. William H. Hill, Manati, P.R.

A liquid fuel vaporizing device comprising, in combination, a vaporizing chamber having a differentially heated wall surface upon which the liquid fuel is directed and over which it passes in the direction of increasing heat, and means for heating said surface arranged to cause the hotter part of said surface to be heated by conduction through the wall and for causing the less heated parts of said surface to be heated only by conduction along the wall.

Electric Furnace. No. 1,436,497, American. James H. Gray, New York.

The combination with a tilting furnace of electrode adjusting mechanism for said furnace, said mechanism comprising a motor mounted independently of the furnace and a flexible connection extending from said motor to the electrode, one part of said connection extending from the motor to a member mounted on the furnace and engaging said member at a point which is substantially unchanged when the furnace is tilted and another part of said connection extending from said point of engagement to the electrode, whereby the latter is held in substantially the same position with reference to the furnace when the furnace is tilted as when it is upright.

Electrolytic Condenser. No. 1,437,189, American. Ralph D. Mershon, New York.

In an electrolytic condenser, an outer vessel containing an electrolyte, an inner frame of insulating material immersed in the electrolyte, and a series of electrodes immersed in the electrolyte in said frame, all of which electrodes are active and of which the electrode at each end of the series is of lesser area than the next adjacent electrode, for the purpose set forth.

Process of and Apparatus for Welding. No. 1,437,257, American. Royal Mattice, Philadelphia, Pa.

The process of welding cast iron or steel objects having a substantial percentage of carbon which consists in applying an electrode thereto with the application of heat, said electrode comprising ferrous material, and substantially 15-30 per cent copper, for the purpose specified.

Furnace Lining. No. 183,219, British. Ferolite, Ltd., and H. B. Clapp, London.

The lining of gas-producers, electric furnaces, crucible furnaces, and the like, is made from a mixture of chromatic and ferro-silicon ground to a suitable fineness and mixed with a binding material such as sodium or potassium silicate. The plastic mass may be made into bricks or slabs or may be tamped in a continuous layer round a core.

Furnaces. No. 183,373, British. J. S. Atkinson and Stein & Atkinson, Ltd., Westminster.

A tank glass furnace is provided with a regenerator having hollow blocks placed one upon the other in rows spaced apart, the blocks in each row being spaced apart. The gas passages from the producer run side by side with the heated-air passages, into which they discharge through ports. The burners are situated at one end of the tank chamber, and the waste gases are withdrawn through ports near the ends of the side walls.

Forging of Metals, Stuffing Boxes, Piston Rods. No. 183,646, British. A. S. Marshall, Glasgow.

In a power hammer, the piston-rod, stuffing-box, and gland are made of oval or elliptical cross-section to prevent the piston from turning. Similarly, the tup face is secured by an oval or elliptical projection. A key and dovetail connection may also be provided, or the tup may also be recessed and fixed on the end of the oval or elliptical piston-rod.

Drawing of Wire. No. 183,807, British. Nammlooze Vennootschap Phillips' Gloeilampenfabrieken, Eindhoven, Holland.

Dies for drawing tungsten wire, etc., are made from an alloy of tungsten and cobalt. The alloy may consist of 75 to 5 parts of tungsten to 25 to 5 parts of cobalt. The dies are made by producing the alloy by a thermo-aluminic process and then drilling and polishing. The alloy made may be sufficient to form a single die or a number of dies, in which case it is first sawn into pieces. In order to make the alloy, tungstic acid and cobalt oxide are first freed from moisture by heating at 400 deg. C., and are then mixed with fine-grained aluminum and fused in the ordinary way.

Coking. No. 184,144, British. H. Koppers, Essen, Germany.

In the distillation of carbonaceous materials, particularly at low temperature, the heat is imparted to the charge in the retort by heated solid bodies which are afterwards separated from the residue. Steel balls of about 100 millimeters diameter are heated to about 800 deg. C. in a furnace and are fed along a duct into a revolving drum, to which the charge is supplied from a hopper. A worm, provided in the drum, serves to convey the charge through the drum and to a screen through which the residue such as semi-coke falls into a hopper, the balls traveling down a covered channel, from which they are raised to an inclined runway leading back to the furnace. The distillation gases pass off through a pipe and main.

Articles in June Iron Trade Review

Following is a brief summary of some of the principal articles appearing in Iron Trade Review during the month of June.

May 31

A better feeling is noted in the iron and steel markets following the expression of confidence by E. H. Gary at the meeting of the American Iron and Steel Institute, New York, May 25. April iron and steel exports show substantial gain, reaching 183,509 tons, largest monthly total since June, 1922. The past week's structural awards, 7,442 tons, are smallest in volume since last September. Tin mill and tin house workers advanced approximately 10 and 11 per cent by the new working agreement with the Amalgamated association.

Pig iron prices in the British and continental markets soften and little trading is being done in iron or steel. French buyers, though receiving low American offers on coke, complain that condition of coke after its arrival greatly detracts from its usefulness.

The report of the special committee of the American Iron and Steel Institute to investigate possibilities for abolishing the 12-hour day is presented in full. Many of the technical papers read at the institute meeting are presented in this issue.

June 7

Another phenomenal record of pig iron production is registered. The total output of coke iron in the United States in May was 3,866,386 gross tons, exceeding the previous high record of April by 320,078 tons. Steel works and mill operations in May also were on a record-breaking scale, though hot weather conditions began in June to cut down schedules. Heavy buying of steel still in progress, with the pig iron market generally quiet.

European prices continue to soften and the possibility of new exportations to the United States is reopened by offers of Belgian and French foundry iron at $25, continental ports. The price of reparations coke from Germany is reduced in France for the first time this year, though the shortage of the supply is acute. Pig iron production in France is 65 per cent of that before the occupation of the Ruhr. Germany lifts restrictions on importations of foreign ore to the Ruhr.

The war department's new plans for converting industries from peace to war-time basis are described in an article by the Washington correspondent of Iron Trade Review. A proposed form of blanket contract is presented practically in full.

Annual spring meeting of American Society of Mechanical Engineers, Montreal, May 28-31, is devoted to discussion of problems dealing with development of Canadian resources.

June 14

Steel ingot production in the United States in May, amounting to 4,200,000 tons, established a new monthly record, though the average daily rate was slightly less than in April. Steel orders continue in large volume; the railroads in the past week closing for 250,000 tons of rails.

The European markets remain dull and weak; 70 per cent of the by-product ovens in the Ruhr district cold.

Recent progress made by independent iron and steel manufacturers in adopting the 8-hour shift is described.

The significance in the distribution of the mineral resources of the principal countries is outlined by R. C. Allen, vice president of the Lake Superior Iron Ore Association. Iron ore and coal inventories now among the handbooks of diplomacy.

The business cycle and how to avoid extremes in fluctuations is discussed by the Taylor society at its meeting in Syracuse, N. Y., June 7-9. Group studies of management problems held at various plants visited.

An illustrated article is presented on heat treatment to remove strains in castings. Large turbine frames and other castings of a similar character are treated in an electric oven, the temperature being raised to approximately 700 deg. F.

June 21

Miscellaneous steel business continues in large volume; bookings of plates for the third quarter and revival of interest in oil storage tank capacity especially being noted. The price of 110 to 130-pound rails is advanced $2 to $45 by one large producer. Pig iron sales still small, and the market generally weaker.

Exports of iron and steel in Great Britain in May, totaling 435,600 tons, set a new monthly record. France prepares for a long struggle in the Ruhr, taking measures to obtain supplies of coke for the winter. Germany buying more American coal. Belgian trade suffering from effects of a railroad strike, though the strike is ended.

Many constructive trade factors are analyzed in the weekly review of business conditions. The business trend is shown graphically by a series of weekly charts.

G. M. Hohl, superintendent of blast furnaces, Bethlehem Steel Company contributes an illustrated article dealing with the experience at an eastern Pennsylvania stack with the lifting of a brick column at the furnace top. Present results of investigation of excessive pressure caused by amorphous accumulation between wearing plates.

National Research Council, Washington, prepares to publish basic chemical and physical information on technological materials.

Effects of tin on steel is described in an abstract of a paper presented at the London meeting of the Iron and Steel Institute, May 10-11.

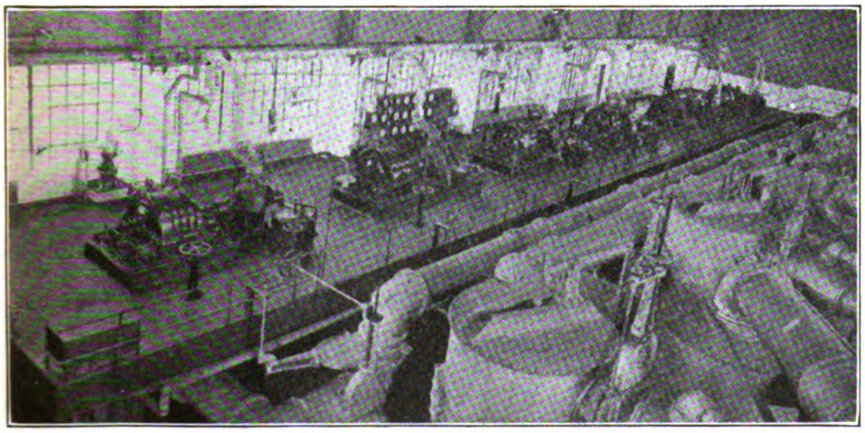
Oil Purification

Experience Shows That Lubricating Oil Becomes Loaded With Impurities More Quickly in Steel Mill Operation Than in Any Other.

Anyone who lives in or near Pittsburgh, Chicago, Buffalo, Cleveland, or any other great steel center, will vouch for the fact that a steel mill is a smoky, dusty, dirty place. It can readily be seen that in such a plant the problem of furnishing proper lubrication to high-speed machines becomes exceedingly difficult. Even the enclosed lubricating system of a steam turbine does not seem to shut out the dust and dirt which are in the air throughout the plant.

That is why De Laval Oil Purifiers are installed at the Carnegie Steel Company's plants at Mingo Junction, Ohio; Duquesne, Pa., and New Castle, Pa.; at the American Sheet & Tin Plate Company's plant, Vandergrift, Pa.; at the Youngstown Sheet & Tube Company's plant, Youngstown, Ohio; at the Pittsburgh Seamless Tube Company's plant, Beaver Falls, Pa.; at the Republic Iron & Steel Company's plant, Youngstown, Ohio; at the Trumbull Steel Company's plant, Warren, Ohio, and in several other equally well-known mills.

At the Cambria Steel Company's plant, at Johnstown, Pa., the complete purifier shown in the accompanying illustration is keeping clean oil in the lubricating systems of six turbine-driven blowers and exhausters in the by-products coke plant. Regardless of whether they are installed, units such as these should always have the protection afforded by a modern oil purifier. In this particular case such protection is more than ever desirable, not alone because the units are installed in a steel mill, but because the blower room is located quite near the coke oven itself and there is more than the usual amount of dust and dirt in the air. It is, perhaps, needless to state that such of this as gets into the lubricating systems does not stay there long enough to do any harm, for it is almost immediately removed by the purifier.



Blower room and the six turbine-driven blowers and exhausters at the Cambria Steel Company's Johnstown, Pa., plant. At the left is shown the DeLaval oil purifier which is protecting these units.

As an example of the abnormally bad condition in which lubricating oil is often found in steel mills and the effectiveness of modern oil purifiers in restoring its lubricating value, the excerpts from a report of the supervising engineer of one of the largest oil companies will prove of interest. The report covers a series of tests made for an Ohio steel mill sometime ago. The quotations and figures given below relate to Test No. 5 which represented one of the worst batches of oil encountered.

The report reads: "The oil used in connection with this test was taken from the gravity circulating system of the blowing engine room. The capacity of the oiling system is about 12,000 gallons. However, at the present time the system contains approximately 9000 gallons of oil. One barrel of oil for test purposes was taken from the return tank of the system. The results of the analyses which follow will show the condition of the oil in this system when delivered to the return tank and before passing through the centrifugal purifier connected with the system."

After purification this oil was returned to the lubricating system in a proper condition for efficient lubrication. This part of the report concludes as follows: "This test showed that with the oil in the condition of that used in this test it can be thoroughly purified, and the purified oil returned to the bearings with its necessary high lubricating value which would naturally prolong the life of the oil in the system to an indeterminable period."

In concluding the entire report this well-known engineer says: "The remarkable showing made by the oil purifier, its simplicity in the construction and accessibility to all parts, the efficiency of the machine in general, the small amount of floor space required and the small amount of attention necessary to keep the machine in operation, in the writer's opinion, make it a valuable and profitable device to be used in connection with oiling systems. It assures the oil consumer of absolutely pure oil being returned to the bearings which would greatly decrease the cost of maintenance, as well as a minimum oil consumption. Also the oiling system would be reduced to a minimum. From the writer's observation during the above tests there is no doubt but that these purifiers will separate to their full capacity all lubricating oils in an average condition. The oils tested on each of the above tests were abnormal and only a very small percentage of the oil could be reclaimed through the ordinary method of precipitation, and that which is reclaimed through the latter method is used for black oil purposes, representing the cheapest and roughest kind of lubrication in a steel mill. This statement applies to all of the oils with the exception of the oil used on Test No. 5. However, in the latter test the oil was purified and in much better condition than when passed through the filter used in connection with the system from which this oil was taken.

"With the use of the modern purifier it is very plain that emulsions can be broken up, all foreign particles removed from the oil and with ordinary operating conditions where regular allowances are made for makeup of losses through leakage, evaporation and other unavoidable losses that lubricating oils could be used to the full limit of their lubricating value and would result in the desired economy to the oil consumer."

"It is not to be expected that many oil purifiers will be called upon to handle oil in such condition as that which was purified in tests made at this steel mill. Nevertheless there is a great deal of satisfaction in knowing the machine in your power plant is capable of purifying oil in an abnormally bad condition when the occasion demands.

ANALYSIS OF OIL

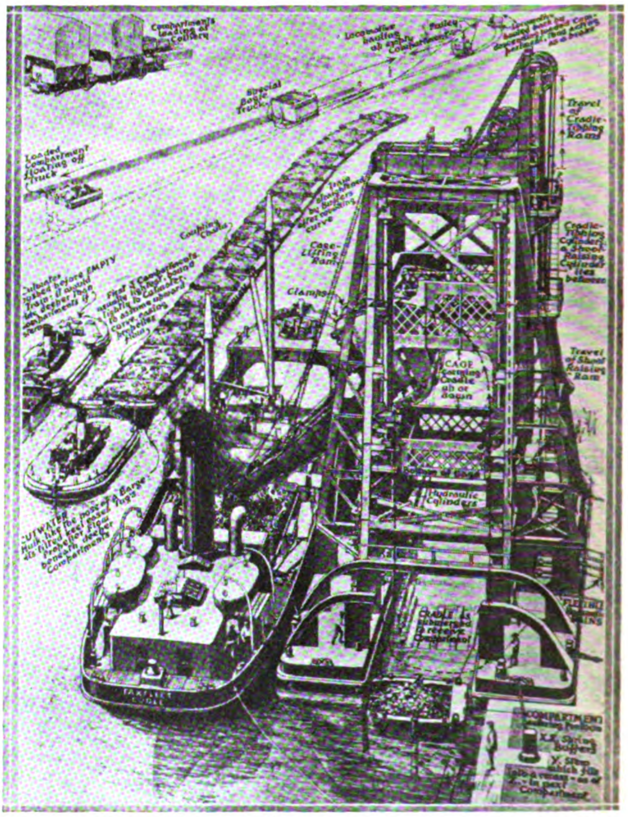
	Before Purifying	After Purifying
Water	25.0 per cent	0.5 per cent
Gravity Be.	18.0	21.2
Flash, open	345 deg. F.	340 deg. F.
Fire	410 deg. F.	405 deg. F.
Univ. Visc. at 100 deg. F.	594 sec.	334 sec.
Ash (Iron Ox.)	0.54 per cent	0.13 per cent
Sed. by 86 deg. Naphtha.	1.7 cc.	0.05 cc.
Free Carbon	1.72 per cent	0.25 per cent
Acidity as SO_3	0.07 per cent	0.068 per cent
Acidity as Oleic	0.52 per cent	0.42 per cent
Compound	None	None
Saponification	4.7	4.8

—Centrifugal Review.

Unique Unloading Method

The July number of Scientific American has a most interesting article on British methods of materials handling in bulk. Americans are prone to believe that Europe has been slow in adopting labor-saving devices; the figure shown tends to disprove any such hasty conclusion.

In a recent lecture before the Institute of Transport in Great Britain, Mr. W. H. French described the remarkable system now in use upon the Aire and Calder Navigation Canal—a waterway which dates back to 1698—for the transport of coal from the Yorkshire collieries to the port of Goole. What are literally "boat trains," comprising up to 20 "compartments" and totaling 800 tons of coal, as depicted in the figure shown above, are used, the entire 450-foot


Compartments loading at Colliery
Locomotive hauling up empty Compartments
Pulley
Special Bogie Truck
Loaded Compartment floating off Truck
Coupling Chain
Cage Lifting Ram
Clamps
Travel of Cradle-Tipping Ram
Travel of Shoot Raising Ram
CAGE carrying Cradle up or down
Hydraulic Cylinders

Digitized by Google Original from UNIVERSITY OF MICHIGAN

train being passed through each lock unbroken, at one "pen" or lockage. Near the colliery, which is shown in the upper left-hand corner of our drawing, the empty compartments are hauled from the water on a rail truck, the coal being dumped at the colliery screens directly into each, and the filled units then re-launched and marshalled into trains.

Arrived at Goole, shown in the foreground, each compartment in turn is shunted by the tug beneath a hydraulic hoist, which lifts and tips each compartment directly into the waiting vessel. Each compartment weighs 52 tons. If the collier is of the self-trimming type, the rate of loading is 400 tons per hour.

This train system, the invention of the late engineer, Mr. W. H. Bartholomew, has handled 3,000,000 tons in one year.

Overlooking Pittsburgh as a Port

The Pittsburgh "Sun" with good warrant takes "The Literary Digest" to task for copying a loose and inaccurate list of American ports and their relative tonnage. The "Digest" list, copied from the New York Journal of Commerce, states New York's total as 19,000,000 tons; New Orleans' as 3,600,000 tons; Baltimore's as 5,100,000; Philadelphia's as 5,000,000; and then amazes itself by finding that Port Arthur, Texas, has a port tonnage on its two ship canals of 4,700,000 tons, almost exclusive of oil, and ranks fifth.

The "Sun" remarks that the Journal of Commerce, the original sinner, can hide behind no quibble of designing to deal solely with ocean ports, for it includes Buffalo, Chicago and even Baton Rouge. It is stated that the New York paper obtained its port comparisons from a report of the Shipping Board.

As the tonnage of the Monongahela, Allegheny and Ohio rivers in confluence at Pittsburgh, a port of entry, in 1920 reached the enormous total of more than 30,000,000 tons, and the total rail and river traffic through this port is estimated at 175,000,000 tons annually we may well ask why it is omitted from the list? Will any such excuse as that the Shipping Board dealt only with ports where its ships touch suffice? Obviously it will not. A standard encyclopedia of the current year asserts without qualification that the tonnage of Pittsburgh is the "largest of any city in the world." Space is not available to quote some of the comments upon the classes of cargoes involved in the tonnage figures thus proclaimed with the absolute ignoring of Pittsburgh, but they only serve to lacerate the wound. Pittsburgh is a regulation port and her tonnage makes that of other ports look rather insignificant.

—Pittsburgh First for June.

Leading Articles in Stahl und Eisen for the Month of March

Page

3-1-1923—Influence of the Method of Preparing Molding Sand on Its Binding Quality and Permeability. Determination of the granulation conditions, the breaking and compression strength of the grains as well as the binding qualities. Conclusions 297

Additions to the Knowledge of the Tempering Process. P. Oberhoffer and J. Welter........ 301

3-8-1923—The Behavior of Manganese in the Basic Open Process. Paul Oberhoffer, Aachen and Fritz Koerber, Ingolstadt. Return of manganese to the bath. Influence of the basicity of the slag, the ore addition, the amount and form of the manganese in the charge as well as the carbon content in the bath. The dependence of the time of melting and the temperature rise of the bath upon the carbon content. Relation of the strength and ductility to the pouring temperature 329

Physico-chemical Observations in Inorganic Chemistry. Prof. Dr. Paul Pfeiffer, Bonn. Constitution of molecules. Isomer appearances. The building up of organic and inorganic compounds. Crystallization. Examples. 334

3-15-1923—The Present Status of the Refractory Industry in North America. Prof. Dr. K. Endell, Charlottenburg. Raw materials. Manufacture of the refractory brick. Care in the manufacture, properties and testing. Discussion 361

A Measure of the Production of Roll Trains. W. Tafel and Er. Schneider, Breslau. Theoretical hourly production without losses and the actual. Efficiency and standard output. Criticism of 31 investigated roll trains................ 370

3-22-1923—The Brown Coal Powdering and Firing Installations of the Steel Plant of Becker Akt.-Ges., Willich. Dipl-Ing. W. Behling. Experimental drying and pulverizing plant for brown coal. Central drying and pulverizing plant. Pneumatic conveyors. Firing of the powdered coal 393

Addition to the Knowledge of Iron-Arsenic Alloys. P. Oberhoffer and A. Gallaschik....... 398

3-29-1923—Performances of Sand Blasts. Ing. W. Koempfer, Durlach. Influence of the air required and the air pressure, of the amount of sand and the sand grains, of the blast angle and the types of blast nozzles upon the output of sand-blasts. Guides for the selection of sand-blasts. Output data....................... 425

The Combustibility of Coal. Dr-Ing. A. Korevaar, Leiden, Holland. New theories as regards the reactions in the gas producer. The influence of the origin of the coal upon the volume of the combustion zone. Volumes and temperatures of the combustion zone. Procedure for determining the combustibility of the coal.

To Extend the Short Day

Iron Age of June 21 Contains the Following Summary of Working Conditions at Trumbull Steel.

Expansion of the 8-hr. day in its open hearth department will be introduced July 1 by the Trumbull Steel Company at Warren, when men now working the longer shifts will be put on an 8-hr. basis.

Analyzing the shorter day and its gradual introduction into the steel industry, a district executive states:

"We are not opposed to the 8-hr. day and we are not in favor of the 12-hr. day. The public does not know that less than 25 per cent of the men employed in the independent plants in the Youngstown district work 12 hours, and seven days a week, while not more than 10 years ago almost 75 per cent of the men worked 12 hours, seven days and six days per week.

"The establishment of a shorter workday in the steel plants was gradual. The men had to be educated first to accept the 8-hr. day at somewhat lower pay than they were receiving for 10 or 12 hours' work. In case of high wage earners and older men this educational process progressed easily and there was no trouble in establishing shorter working periods, but the younger, more ambitious and lower-paid element still prefers the longer day and would resent shorter work days unless they get the same pay they are receiving now. Many of them even then would ask for jobs where they could put in more time.

"Today the long day is in practice in two departments only. They are the blast furnaces and the coke works. There are 12-hr. shifts in other departments, but the number of men engaged is very small. Not very long ago workers of the open hearth department went on an 8-hr. shift in three plants in the Youngstown district.

"Work at the blast furnaces and coke ovens is not only continuous, but absolutely mechanical. Putting three shifts to work in the blast furnaces will not increase production a single ton. It does not make any difference in furnace operation if two or three men are in attendance during 24 hours, for the time of the heats is the same. Blast furnace workers are actually engaged about three or at the most four hours out of the 12 on duty. Between heats they may rest and many of them sleep. The same is true of the coke ovens. The time of coking is mechanically fixed and shorter working hours for the men in the department would not increase production or make the men more efficient or their work easier.

"If the public would pay at least part of the increased cost of production of pig iron, which is made with coke, and which is the base cost of all steel products, and if the men in the departments could be educated to the point where they would accept the 8-hr. day instead of the more money-paying 12 hr., the 8-hr. day would be universal within a short time, provided men could be found to fill the jobs of the third shift. Today the shortage of labor would make the establishment of the 8-hr. day in the departments which are not working shorter periods almost impossible.

"The pipe mills of Sheet & Tube and Republic Iron & Steel are on a 10-hr. shift. The men on the day shift work six days a week, while on the night shift five nights only are worked. The men change every other week and therefore work only 110 hr. in a full two-week period, or an average of but 55 hr. per week. Not more than two years ago, the same men worked 10 hr. on the day shift and 12 hr. on the night shift, or 120 hr. per two weeks.

"Three shift operation of pipe furnaces would be almost impossible because the bottoms of the furnaces must be renewed and this is done between the time of the changing of the shifts."

The reduction of working hours in the steel mills therefore is a gradual process, which if continued at the same rate as it has progressed during the last 10 years would place the entire industry on an 8-hr. basis in not more than five or six years.

Rolling mill crews, employes in the Bessemer department and all crews in sheet and tin mills, which are the principal finishing units in the Youngstown district, are on the 8-hr. shift, with one of the shifts working but 40 hr. a week. By far the largest number of employes in the steel plants of the Youngstown district belong to the class which works 8 hr. per day. Next come those who work 10 hr. per day, and the smallest number work 12 hr. per day.

Warring on Waste

A Plan That Saves a $70 Expense Every Two Months—A Machine That Raises Output from 40 Units to 300 an Hour — A Sorting Device Which Saves the Time of One Man.

Sorting Waste on the Job

Instead of collecting all waste paper into a heap and then sorting it out, why not sort it at the source, by keeping the various kinds of paper separate from the beginning? The Eastman Kodak Company collects the waste from each kind of paper into a separate bag which is stationed near the process machines that use the paper and make the waste. At the same time the second question arises. When the scrap bag is filled how is it going to be moved? Why not have it in such a form that it is ready to move when it is filled without reloading or rehandling? This resulted in putting waste on trucks. Some of these trucks have wheels of their own, and can be wheeled along from one machine to another. Some of the bag trucks have elevated platforms which are handled by lift trucks the same as everything else in the factory.

The filled bags are wheeled to a scale and weighed, the waste paper from all other plants of the company is baled, stored, sold, and shipped.

All scrap sold or used again is credited to each department by the accounting office after subtracting from the sale price the overhead expense of handling the scrap.

Better Castings with Less Scrap.

Off and on in the past we have had to scrap a considerable number of defective aluminum castings on account of cracks, blow holes, scums, porous structure, and so on.

Our research department gave this matter considerable study and they found that the chief cause of most all our trouble was in the heating and pouring of the charge.

They suggested that we carry out the following instructions which we have done ever since and we are now happy to say that we are making better aluminum castings with less amount of scrap than we have ever done before.

The following are the recommendations as received from our research department.

1. All charges should be under pyrometric control and only good, reliable pyrometers used, which should be checked up from time to time to see that they are accurate.

2. Heat the charge at the lowest possible heat. We find that the size and shape of the casting should govern the heat, as different castings require different heats. When once the ideal lowest possible heat

has been found, a record should be made giving the number of the casting together with the number of degrees Fahrenheit to which the charge should be heated and poured. We find that the higher the charge is heated in melting, the more defective castings have to be scrapped.

3. All pouring should also be done at the lowest possible heat. We find that pouring either too hot or too cold causes blow holes, cracks, rough surfaces, and so on, and also makes a poor looking casting on account of a lack of sharpness in the shape of the casting. We find that by pouring at the lowest possible heat we not only get a greater amount of perfect castings but also castings that are high in tensile strength.

4. When pouring either from two crucibles or two ladles the heat of both should be exactly the same. We find that when two ladles having different heats are used in pouring that the contraction is uneven when the casting is cooling off, which causes cracks and seams in the castings.

Reclaiming Set Screws.

In plants where line shafting and counter shafting are in use for driving the various machines, the iron pulleys on this shafting as well as the pulleys on some of the machines, are held with set screws. In the course of time, these pulleys work loose, due to the fact that the cup joint on the set screw gets dull and will not hold, no matter how tight the screen is turned. Many machine operators waste time in trying to make a dull set screw hold the pulley.

Where this trouble exists, it can be corrected only by renewing the screw. In the average case when the old screw is replaced by a new one the old one is thrown away. Where there are a large number of these pulleys in the plant requiring new set screws a few times during the year, it amounts to quite an item on the maintenance bill.

To reduce this expense, one shop superintendent has all set screws reground on an emery wheel. As the hollow in the cup jointed screw is quite deep the screw can be reground a number of times.

Saving the Time of One Man.

It was just during the past year that many foundries have found themselves in the peculiar situation of facing a shutdown merely on account of the fact that they were unable to secure foundry nails. For this situation there is usually added to the force, a man whose sole duty is to comb the foundry floor for nails which could be used again. But the Standard Manufacturing Company improved on this plan a little by conveying all of the foundry nails directly from the shake-out pit to one reclamation point.

The bucket conveyor which carries the sand from the shake-out pit to the overhead screen naturally takes with it all the nails and metal which are shaken from the tip. The nails and metal are removed from the sand by the ordinary electromagnetic method, and are then conveyed over to the side wall of the foundry where they are dropped down a chute to the foundry floor. It is the duty of one of the laborers to separate the nails which can be used again from the other scrap metal several times a day.

Making Waste Pay for Power.

A southern lumber company had for many years used its own wood waste in making power. This fuel was not sufficient for their needs, so additional power was furnished by a central plant. An opportunity came to sell the waste and they decided to secure all their power from the electric plant even though it was felt that this was sure to mean a loss each month. Several months of practice has shown that the profits from the sales of waste have paid for the electricity and left a neat profit each month.

An investigation by lumber mill owners has shown that there is a profitable market outside the mill which may be developed to absorb all the waste from lumber.

Lowering Belt-guard Costs.

"Heretofore," writes the superintendent of a Vermont factory, "we made the safety guards used for guarding the larger belts throughout our factory out of mesh wire.

"We found this to be a rather costly proposition, and are now using perforated metal, that is, wide sheet metal strips that have been run through a punch press, and from which 7-16 or ½ inch diameter washers or round blanks have been cut, which were used for commercial purposes.

"As these perforated strips of metal are looked upon as scrap and are sooner or later put into the melting pot, it can be readily understood that by using these strips instead of mesh wire that we are affecting a considerable saving on the cost of our safety belt guards.

"When these guards are fastened in position we paint them green. All in all they not only make a good looking belt guard, but are substantial and fully answer the purpose for which they are intended in every way."

Making Shovels Last Longer.

Figures indicating the low life of shovels in railroad use suggest an item of possible economy—often overlooked. An average of 74 track shovels was furnished each working day to a construction gang at a daily expense of $70. Assuming that shovels were used half the time, the average life would be two months—obviously too short a time.

Most shovels are discarded because of damage by abuse rather than wear. Many are broken by ripping up ties; others meet severe damage by being used to drive stakes or other objects requiring a hammer or maul.

Shovels should not be thrown violently from trucks or in handling nor should they be thrown promiscuously in a pile with jacks and other heavy tools or material likely to damage them.

Where shovels are used for handling they should be cleaned after use and oiled if they are not to be used for some time.

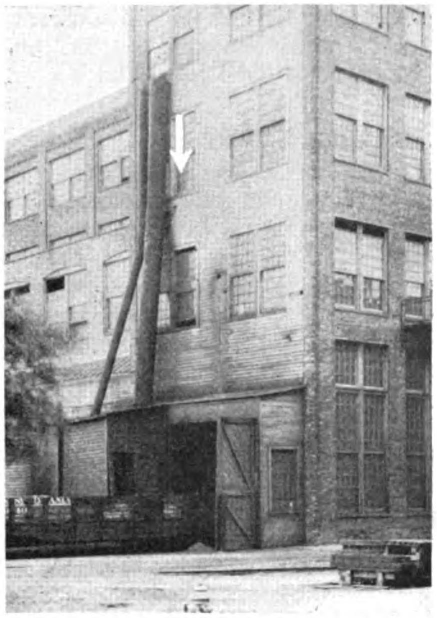
Chutes Which Save Rehandling.

It is surprising what an expensive job the disposition of waste may become, yet it is quite a simple matter to dispose of this waste with the least cost and confusion.

In one factory of the Allis-Chalmers Manufacturing Company, shavings from the milling machines accumulate on the fourth floor and on the third floor. Formerly these were shoveled into wagons and the wagons were taken to the ground on an elevator.

This, of course, required the services of a man to handle the wagon and also a man to operate the elevator. Usually it was necessary to dump the contents of the wagon into a bin after it reached the ground floor and then later these shavings were shoveled into a railroad car to be taken away.

Now many of these operations are saved by the installation of two metal chutes, as shown in the illustration, that conduct shavings from the third and fourth floors into a shed at the side of the building which contains two binds. The shavings are divided according to the kind of metal, and it requires only part of the time of one man to shovel these shavings into the chutes. When enough has accumulated in the bins to make a carload, this same man fills the car.



Separate chutes for waste materials.

—Factory, the magazine of Management.

How Kiln Temperatures Are Measured

When it comes to measuring the temperature of the hottest summer days, the old-fashioned mercury thermometer serves very well. But at 675 deg. F., mercury reaches its boiling point, and is useless for measuring higher temperatures.

In the manufacture of portland cement, temperatures between 2,700 and 3,000 deg. F. are generated in the huge rotary kilns. Many kiln operators have been trained by years of experience to recognize the proper temperature by the color and appearance of the burning materials, but it is frequently considered desirable to take the temperatures mechanically.

With the "Radiation Pyrometer."

One way of doing this is with a "radiation pyrometer." Standing a few feet in front of the kiln, the operator looks through a little telescope, containing a piece of colored glass and two small wires. He trains this instrument on the seething mass inside the kiln, where the raw materials from which cement is made, are being burned to clinker. So intense are the flames that the onlooker is blinded unless he wears colored glasses.

As the operator "sights" the little telescope on the kiln's contents, he picks out the spot in the furnace where the glow is hottest. The telescope acts like a big "sun glass." It focuses the heat on the little wires inside it. The wires expand and move a needle in an indicator box, and the needle in turn indicates the temperature on a disc. It is the work of only a few minutes to ascertain the temperature inside the kiln. Most of the pyrometers will indicate temperatures up to 3,600 degrees.

Trying It on the Sun.

At one of the cement plants the telescope of the pyrometer was turned on the sun, and the little needle on the indicator disc immediately sprang over the maximum figure, bouncing against the side of the box in its effort to record the heat on the sun's body—93,000,000 miles away.

The temperature inside a cement kiln—one of the highest used in any industry—is produced by one of three fuels: gas, oil or powdered coal. In any case, the fuel is blown in under pressure from a jet at the lower end of the long, reclining, revolving kiln and burns in a flame 20 to 30 feet long.

Heavy Fuel Consumption Necessary.

To make a barrel, or 376 pounds of cement, under ordinary conditions, 200 pounds of coal, or equivalent fuel, must be burned—about three-fifths of it in the kiln.

A kiln with a daily capacity of 1,000 barrels of clinker (unground cement) will consume approximately 60 tons of powdered coal every 24 hours—a ton every 24 minutes. —Portland Cement Association.

Relatively Few Accidents in Handling and Testing Explosives

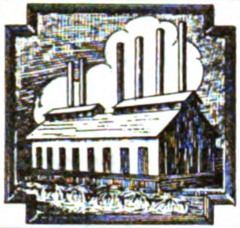
Investigations conducted by the Department of the Interior through the Bureau of Mines relative to the hazards involved in the handling of explosive materials indicate that the number of accidents in handling and testing explosives is relatively low; in fact, it is lower than in some supposedly less dangerous occupations. Workers who handle explosives, being aware of the danger, practice carefulness until it becomes a habit; in consequence accidents are relatively few. Accidents from explosives, however, receive more publicity than do most industrial accidents.

Any feeling of nervousness by a man engaged in handling explosives is highly dangerous, as it may result in his dropping a batch of sensitive material or knocking over a piece of apparatus. Men subject to nervousness should overcome it or get out of the industry. All explosives should be treated with proper respect, but it is not necessary to feel that the slightest jar will be disastrous.

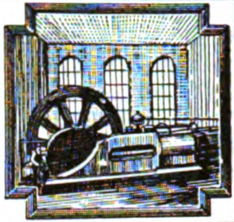
The Bureau of Mines estimates that at least 75 per cent. of all industrial accidents with explosives are caused by hurrying the work and by taking chances where conditions are known to be dangerous; probably 20 per cent. are due to carelessness, the rest having at least fairly excusable causes. The great essential in avoiding accidents is that inexperienced men should be made fully conscious of every movement in handling explosives and should be tained to "play safe" until they are automatically careful all the time. Benzene, toluene, aniline, and their nitro compounds, besides other compounds, are known to be poisonous, but so is hydrogen sulphide, which all chemists use.

When preparing samples of explosives many analysts wear rubber gloves, but the usual course is to see that the hands are dry to avoid direct contact as much as possible When wash the hands as soon as the sampling is finished. When possible, it is best to bathe the hands in a dilute solution of sodium sulphite, which acts as a solvent and is not readily absorbed by the skin.

Digitized by Google Original from UNIVERSITY OF MICHIGAN



STEAM POWER DEPARTMENT



Pulverized Fuel for Large Boilers*

An Interesting Analysis of Exceptional Combustion Results Obtained at Brunots Island Plant of Duquesne Light.

By J. C. HOBBS† and L. W. HELLER‡

THIS paper covers an investigation into the possibilities of burning coal in pulverized form in furnaces designed to produce heat for generating steam. The paper is divided into two main parts. The first part deals with the tests and results of experimental installations and the second part with the general analysis of the problem, including the solution which now appears most logical.

Since the investigation was first started, many interesting and valuable developments have been made in the art. The results already attained have been so satisfactory that large installations are being made not only in Pittsburgh, but in many other places.

Coal has been burned in powdered form for many years, and the Pittsburgh District has had a part in its history. During later years, however, there have been larger and more spectacular installations made in the Middle West, notably at Milwaukee and Detroit. It is not the purpose of this paper to give a history of the development, but rather to furnish a statement of the results obtained from an installation designed for the express purpose of determining the value of this method of combustion when applied to the large boilers used in modern central stations.

While the concentration of generating equipment in large plants has very greatly reduced the coal consumption per kwh., the decreased cost, the ease with which electrical energy can be obtained, etc., etc., have resulted in such a great increase in the use of electricity that the total coal consumption has also greatly increased. The quantities of coal necessary to furnish the enormous amount of electrical energy which the demand in a district such as ours requires, are so great that a careful investigation of any possibilities is justified, so as to insure the furnishing of service at the lowest practical cost.

Combustion itself is not a new art; and while certain of the results which will be presented may appear in a new form, no credit is claimed for the performance achieved, except such as is due those who have been diligent in carrying out the details of such an investigation made possible by the size of the organization and the policy adopted by its management.

At the time this investigation was authorized, it was felt that the art had progressed to such a point that full information was needed in order to insure, against obsolescence, the large investments in power plants which must be made almost continuously to serve the demands of our community. Complete information can only be obtained in a first hand investigation. It is not practical or even possible to report all of the results and conclusions reached in the various studies of the many factors involved. In addition to the great advantage of obtaining definite first hand information, it was felt that the time had arrived when a contribution in the development work would be justified, and that any further delay in order to "let George do it" at his expense was a costly policy to pursue for all concerned.

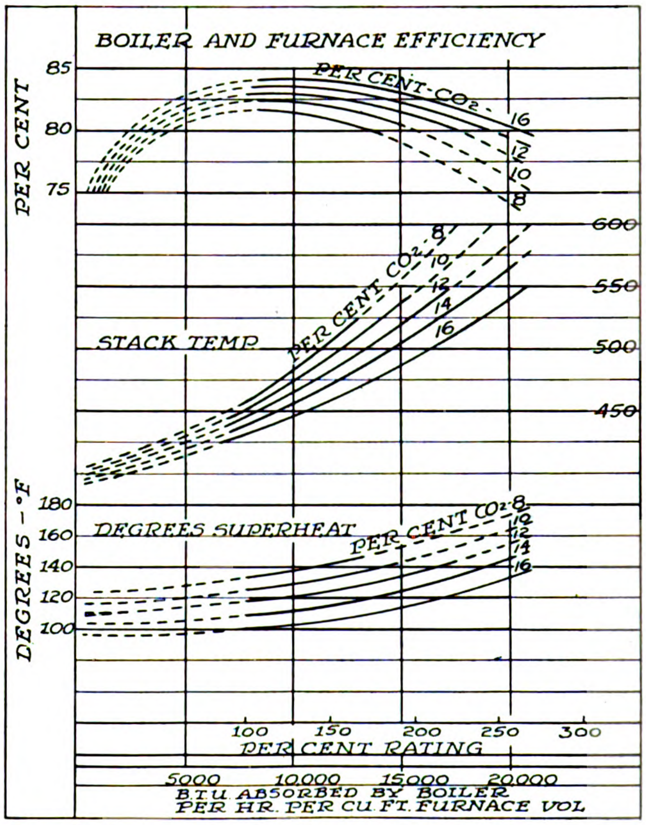


FIG. C-1—*Curves showing results with 4-pass. baffles.*

Description of Installation.

Tests were conducted on a Stirling boiler, Type M-30, nominally rated at 822 hp., to which was attached a water screen having 180 sq. ft. of heating surface, and an additional nominal rating of 18 hp., totaling 840. During the first test, the boiler was equipped with a B. & W. superheater having 255 sq. ft. of surface. During later tests this superheater was replaced with a larger one having 1,031 sq. ft. of surface. During the first test the boiler was baffled so as to obtain three effective passes. The later tests were made with a four-pass baffle.

---

*Paper delivered before the Western Pennsylvania Engineering Society, June 5, 1923.

†Manager, Allegheny County Heating Company.

‡Superintendent, Brunots Island Plant, Pittsburgh.

A special furnace was built with a large combustion chamber and air-cooled walls. The pulverizer or milling plant consisted of one standard 6-ton 6-roll Raymond mill, together with exhauster fan, separators, and the usual piping.

The testing equipment consisted of operating coal scales for weighing the coal fed to the pulverizer, water weighing tanks and scales, and all other miscellaneous gauges, manometers, thermometers, pyrometers, and apparatus required to make a complete boiler test.

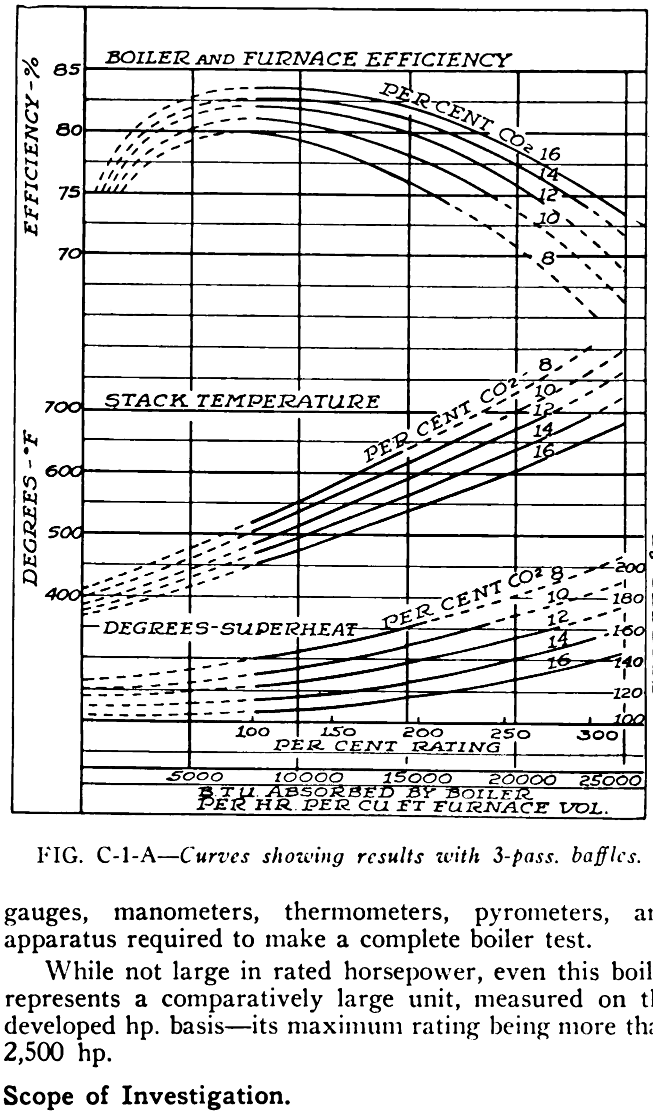


FIG. C-1-A—*Curves showing results with 3-pass. baffles.*

While not large in rated horsepower, even this boiler represents a comparatively large unit, measured on the developed hp. basis—its maximum rating being more than 2,500 hp.

Scope of Investigation.

The scope of the investigation was made broad to determine the real value of this method of firing when compared with the best standard practice in central stations. Some of the more important factors are:

1—Combustion efficiency.
2—Boiler absorption efficiency.
3—Effect of superheat produced.
4—Capacity of boiler.
5—Banking losses.
6—Capacity of stacks.
7—Flexibility and ease of operation.
8—Time required to put a boiler on the line.
9—Labor required for operating boilers and pulverizing plant.
10—Maintenance costs of the boiler, furnaces and pulverizing plant.

Results.

In order to make it easy to analyze the various factors and the effects produced, the great mass of tabular data has been digested into curves which present the conclusions almost at a glance.

During the investigation certain major changes were made to determine their effect:

1—A change from a three to four-pass baffle.
2—The original superheater was replaced with one having more surface.
3—Two different types of pulverized fuel feeders were used.

The original superheater is referred to as "Superheater A," the last one as "Superheater B"; the original feeders as "Feeders A," and the latter ones as "Feeders B."

Fig. C-1 shows: (a) Variation of boiler and furnace efficiency; (b) Stack temperature; (c) Superheater temperature at the various furnace ratings, expressed in Btu. absorbed by the boiler per cu. ft. of furnace per hour.

Fig. C-2 shows the relation between CO_2 and (a) Load of boiler rating, (b) Stack temperature, (c) Superheat, and (c) Draft loss.

This curve is one which we have often talked about, but never before had an opportunity to obtain from actual test, it being impossible to determine on the ordinary stoker job the effect of a variation of the CO_2. Other factors vary so much that no definite conclusions could be reached. This curve is particularly interesting because it shows very conclusively that stack temperatures are greatly affected by the percentage of CO_2. The superheater is also affected, and in this connection it should be mentioned that superheaters which are to be installed in powdered fuel installations should either be located closer to the furnace or have more heating surface in order to obtain the same amount of superheat in the steam.

The draft loss data is also very striking. It indicates that increased boiler capacities can be obtained with the same stack and baffle arrangement, by simply reducing the amount of excess air, which is equivalent to increasing the CO_2. The explanation is simple. The total quantity of gas which must be handled is greatly reduced, and friction loss through the boiler and the stack is reduced inversely as the square of the volume of gas. Fig. C-3 tells the story.

Many years ago it required some explanation to convince engineers that an increase in stack temperature might be due to an increase in the excess air; but I believe it is now very generally understood that the stack temperature has a tendency to increase with the amount of excess air admitted to the furnace up to the point where the furnace temperature is affected, after which, due to extreme dilution, the final stack temperature is reduced.

Fig. C-4 shows an analysis of the power consumption for the entire operation, consisting of pulverizing, separating, transporting, storing and feeding. Some development work towards the reduction of this power has already yielded good results. In making an analysis of power and consumption in connection with the combustion problem, care should be taken to prevent the omis-

Digitized by Google Original from UNIVERSITY OF MICHIGAN

sion of the various operations required by some of the stoker methods. A comparative analysis which would show the relative merits between all of the various combinations of elements which enter into a stoker or pulverized fuel installation, is not possible or practical in a single paper, nor could you spend the time in any one evening to thoroughly discuss the entire subject. Each type of stoker, and each particular installation, needs to be analyzed separately.

Conclusions.

Some of the advantages which can be realized are as follows:

First—Increased boiler capacity.

Second—Increased stack capacity.

Third—Increase in the sustained boiler efficiency.

Fourth—Decrease in the amount of fuel required for banking due to a reduction in the amount of coal in the furnace.

Fifth—Increase in the efficiency of combustion to supply heat loss, and the ease of sealing the furnace and boiler during the banking periods.

Sixth—The number of banking hours is also reduced, because it is not necessary to carry as many boilers under bank, it being possible to start a fire under a comparatively "cold" boiler in a relatively short time. It reduced the furnace maintenance under high ratings due to the elimination of metal from furnace construction.

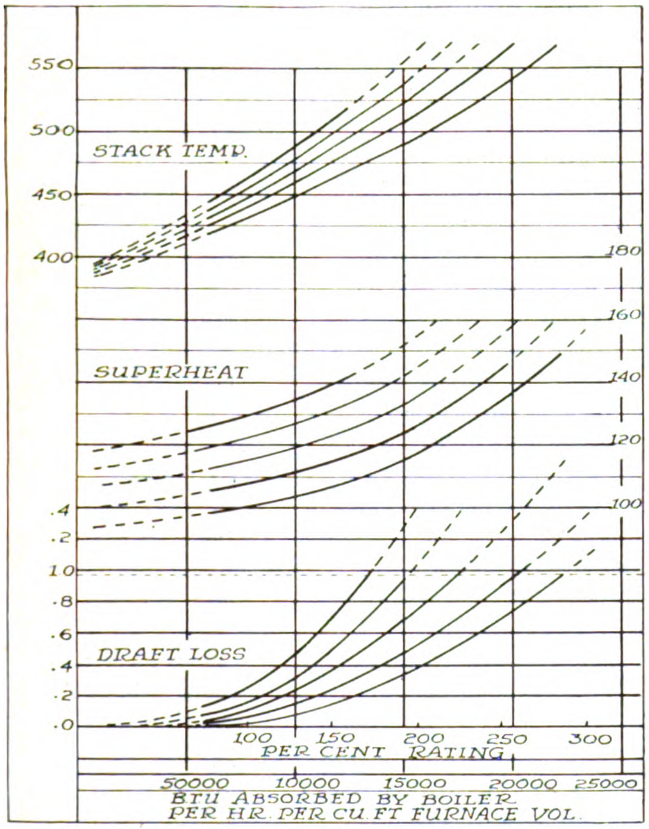


FIG. C-2—*Curves showing results with 4-pass. baffles.*

Analysis of Problem.

Before proceeding with the solution of this problem, let us first clearly define it in the following manner:

1—Exact object or ideal sought.

2—The practical difficulties or problems which must be solved in order to attain or approach the ideal.

3—The available resources.

4—The solution or method which appears to be the most logical and practical.

The ultimate object of the engineer was quite well indicated by some "illustrious Webster" when he stated that an engineer is "One who makes use of the resources of nature for the benefit of man." If he was right, and I am inclined to believe that he appreciated the function of an engineer more than many engineers, then the practice of even our expert engineers today must either be improved, or the definition will become so greatly modified by usage that the dictionary will need extensive revision in order to accurately indicate the commonly accepted definition. It is humiliating to admit that engineers of the present, as a class, now make actual use of only a very small percentage of nature's resources, and throw away or waste the major part.

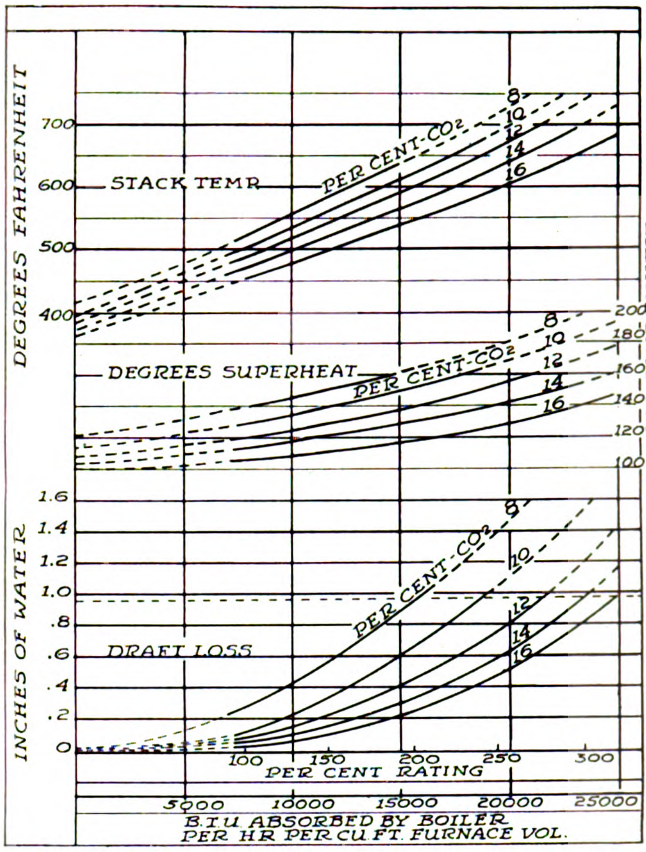


FIG. C-2-A—*Curves showing results with 3-pass. baffles.*

In our particular combustion problem, the object or the ideal sought is to convert all energy contained in the fuel used to that form which is best adapted to serve mankind, i. e., "power." The ultimate conversion for most of the energy contained in fuel usually takes the form of power, because power is the greatest servant of man. It relieves him of unnecessary physical labor and drudgery and it directly and indirectly is responsible for practically all of the comforts of modern civilization. Without it we would have no transportation and the many other elements which make possible the social, intellectual, and business life of today.

Since most of the power is today produced by fuel through the medium of the heat cycle, our analysis will be still further limited to the generation of heat.

Heat generation combustion is usually considered as the chemical combination of two elements, with the resultant increase in temperature. Some elements combine without any change in temperature, and others with a decrease in temperature.

1. *Ideal.*

It would be ideal if we could generate all heat contained in fuel and transfer all of it to steam or other vehicle used in the power cycle.

Practical Difficulties.

EXCESS AIR

During the process, the products of combustion are usually discarded at temperatures higher than that at which they enter the process, thereby carrying away valuable energy. This loss is reduced by a reduction in the quantities. Excess air in combustion represents one of the larger losses, so that its elimination represents one method of saving. This elimination also assists in improving the efficiency of the absorption processes.

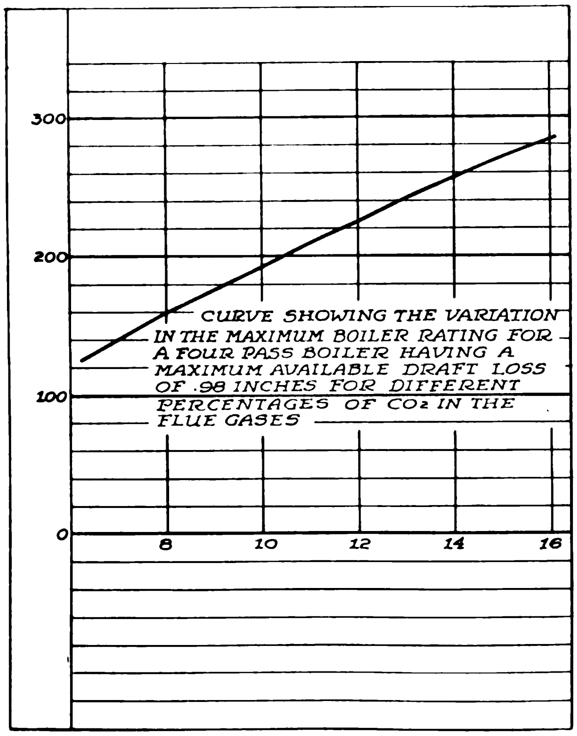


FIG. C-3—*Curve showing results with 4-pass. baffles.*

COMBUSTIBLE LOSS

Foreign matter in fuel, usually known as ash, prevents the combustible material from being burned. Combustible material may also be lost in poorly designed furnaces, through the stack in solid and gaseous form due to incomplete combustion.

FURNACE CONSTRUCTION

Commercial materials used in furnace construction have not permitted the maximum temperatures to be obtained without serious damage.

ASH REMOVAL

The separation of the ash from the combustible, and its removal from the furnace is always a problem.

RADIATION LOSS

Radiation through the side walls and from the boiler has been hard to eliminate without damage to the furnace.

ABSORPTION

Ash from the combustion process has a tendency to adhere to the boiler absorbing surface in the form of clinker and dust, thereby reducing the rate and quantity of heat absorption.

BOILER RELIABILITY

Boiler tubes have a tendency to fail more frequently with higher furnace temperatures.

PRACTICAL OPERATION

Combustion in the past has been almost entirely a "hit and miss" process. Proper control of the quantities has usually been impossible because the operators were not furnished with the facilities required to obtain accurate control. The materials in the apparatus used in the past for burning fuel have usually failed more rapidly when efficient combustion was obtained. The maintenance of the apparatus formerly used in the combustion process not only cost considerable, but required the boiler, and sometimes other apparatus, to be taken out of service while repairs were being made, thereby making an additional overhead expense chargeable to the combustion process.

EXACT OBJECT OR IDEAL SOUGHT

In every day language, the ideal system is one in which all of the coal is burned, and all of the heat generated is transferred to steam; and the apparatus for obtaining this result so reliable that it can be kept in service practically continuously without maintenance cost.

Available Resources.

The resources available today are as follows:

FUEL

The available fuel may contain large percentages of moisture, ash, sulphur, iron, etc.

MATERIALS

Boiler materials which are very good, but limited to a reasonable temperature without failure.

Commercial furnace lining which will withstand a temperature of something over 3,000 degrees, but which will fail under operating conditions at temperatures lower than are obtained with most efficient combustion. Some refractories will resist higher temperatures, but their cost appears prohibitive on account of the large quantities received.

Operating labor with an average intelligence properly trained to do specific work.

The cost of obtaining highly trained technical men to control combustion under the operating conditions is prohibitive in many cases.

Practical Solution.

One solution of the combustion process which appears to the writers to be practical, consists in firing of coal in powdered form so as to make the process uniform, reliable and controllable. The furnaces are constructed of the best grades of refractory material, and are prevented from failure by limiting the temperatures to which they are subjected. This is done by cooling the furnace walls by means of air and water, so that at no time should the temperature of the refractory exceed the temperatures which they can withstand without injury. The temperature of the refractory depends upon the rate of heat absorption by the refractory from the furnace, and the rate at which it is permitted to give up its heat.

The solution which appears most practical incorporates the various commercial material available into a system in such a way that none of the materials are subjected to stresses and temperatures beyond which they are as absolutely dependable. Metal is eliminated from the interior of the furnace. Refractories are cooled to such a temperature that slag accumulates and forms a protection, and the furnace design made such that no penalty need be paid in the form of lower efficiency in order to prevent damage to the brickwork.

Combustion of coal seems to be more complete when the coal is fed to the furnace in powdered form than when fed by stokers. Pulverizing alone does not insure complete combustion, but it forms a prerequisite to a thorough and quick mixing of the carbon, hydrogen, sulphur, etc., in the fuel, with oxygen of the air—the other element which sustains combustion.

In this connection, it might be well to point out that oxygen is just as much a fuel as carbon, hydrogen and sulphur, and that because of the fact that the oxygen used is mixed with five other parts of nitrogen, an inert gas, it is very important that as little as possible be used in the combustion process, because the nitrogen and the excess oxygen absorb heat which cannot easily be extracted from it before the product is again given back to the air.

The trend of the modern boiler furnace design for several years has indicated to the writers that the ultimate furnace should be water cooled.

Five or more years ago much attention was being given to the insulation of boiler walls. Insulation can be used to good advantage on that part of the boiler setting which is not exposed to extreme temperatures; but in order to maintain the furnace lining, it was later found that the insulation should be removed from some parts and the wall thickness decreased in order to save the furnace. Insulation can be used successfully provided some means are incorporated to absorb heat from the furnace lining fast enough to keep the inside surface below the failure temperature.

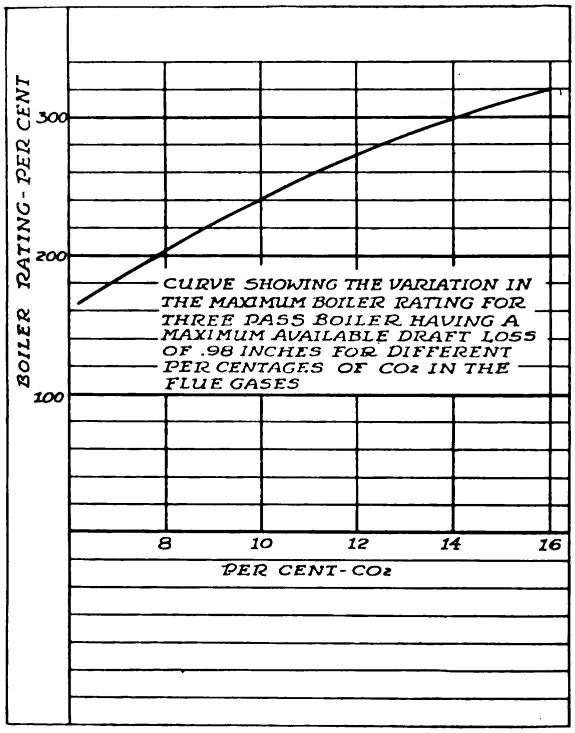


FIG. C-3-4—*Curve showing results with 3-pass. baffles.*

Air cooling has been used with advantage, but it has the serious disadvantage of requiring air circulation to be continuous, which action interferes with the accurate and absolute control of the air supplied to the furnace. Air cooled walls require a very high grade of engineering design to meet the various conditions. The ratio of radiant heat absorbing surface to refractory surface, the quantity of wall cooling air, its velocity and the location of the cooling zone must all be considered. The strength of the furnace lining, particularly after it has become thin by flame and slag action, gets to the point where it is not very strong. An air cooled furnace should have its walls inclined away from the heated side; and with tall furnaces, the combustion space is very greatly reduced due to the tapering inward at the bottom with such a design. For instance, in a furnace 30 ft. in height, which is being used in some installations today, an inclination of only one inch to the foot results in a furnace 5 ft. narrower at the bottom than at the top. With even this much slope, such a furnace would be quickly burned out if the supply of air for cooling is reduced or shut off during a heavy load.

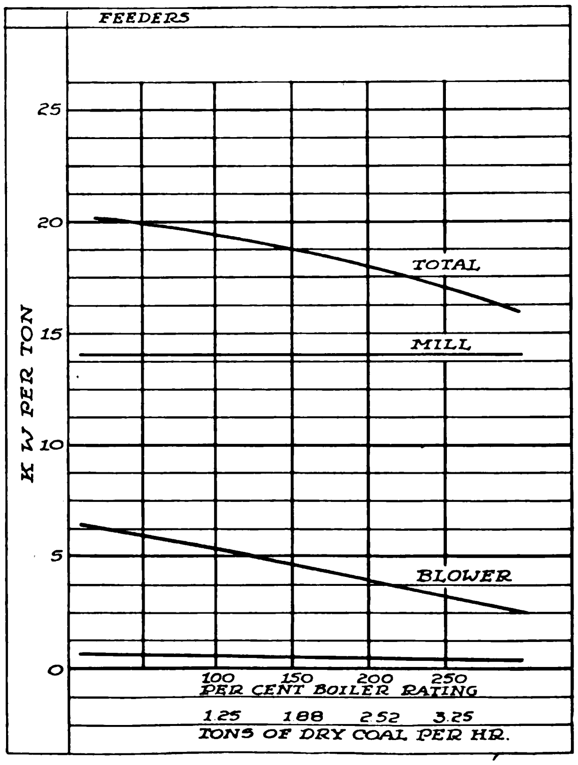


FIG. C-4—*Curves showing power consumption with "B".*

With the water cooled furnace, experience has proven that the temperature of the brick can be maintained below the melting point, and enough slag accumulated to actually protect the brickwork.

The adoption of cooled walls also permits the use of metal hangers such as are used in the suspended arch construction, so that vertical walls can be utilized.

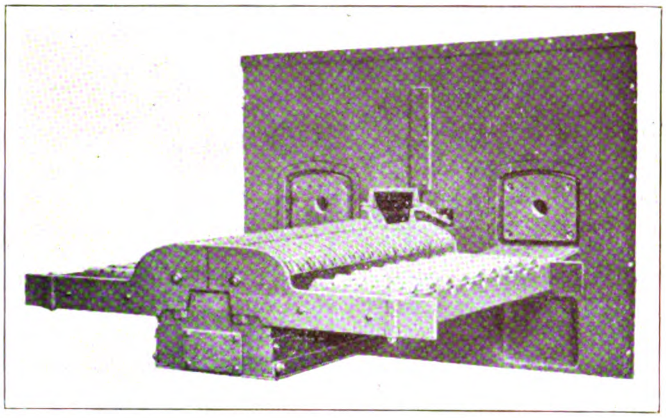
Furnace Volume.

The writers are very much of the opinion that powdered fuel furnaces in the future will operate on a higher Btu. per cu. ft. basis with this type of furnace construction, because it will be possible to make more complete use of the furnace volume. Even the impingement of flame at high velocity on the walls could be allowed without danger.

We are told by scientists that combustion takes place more rapidly with higher temperatures and with higher relative velocities between the combustible elements. Both of these advantages should be obtained.

TRADE PUBLICATIONS

The Combustion Engineering Corporation have just issued a new bulletin K-1-1923, describing type K stokers. "Type K" is a successful adaption of under-feed stoker for small boiler units up to 200 hp. The cut shows an interior view as assembled ready for operation and gives an excellent idea of its simplicity and ruggedness. The green coal is forced upward through the bed of live coals by the action of the pusher block,—the volatile gases are slowly distilled off and the coal ignites. The tuyere fire bars,—through which combustion air is admitted, are interchangeable and easily replaced. Siftings are reduced to a minimum. By the use of a special operating valve and large steam cylinder,—exceptionally low steam pressures may be utilized. Sliding auxiliary dampers permit admission of air to side grates or dump grates. Automatic regulation can be applied if desired.


Type "K" stoker.

A new catalogue well illustrated, is being distributed by the American Heat Economy Bureau, sole agents in the United States for the Selas System for the Industrial Application of Gas for the Steel Industry.

A trolley folder has just been issued covering the new Yale Trolleys. It is the first piece of literature to be issued on this equipment, and contains, in addition to detailed descriptions of the plain and geared types of the new Yale Steel Plate Roller Bearing Trolleys, a description of the new Yale Cast-iron Trolley. Incorporated in it are the details of very interesting tests to which the new Steel Plate Trolley was subjected, and a complete list of the material-handling equipment manufactured by the Yale & Towne Mfg. Company.

The Westinghouse Electric & Manufacturing Company has issued the first number of a miniature publication entitled "Electric Heat". This publication which will be published frequently is devoted to industrial electric heating problems. In this issue there are articles concerning the use of electric heat in the manufacture of storage batteries, electric motors and many other subjects. Of especial importance are articles by Professor W. Trinks of the Carnegie Institute of Technology on "Advantages and Limitations of Electric Heat" and" Reduced Labor—A By-Product", by M. R. Armstrong. The method of calculating power requirements of electric ovens is given together with a number of ways in which hard jobs may be made easy by electric heating.

The Conveyors Corporation of America, 326 West Madison Street, Chicago, Ill., have just issued a handsome booklet, "Representative Installations." The booklet contains illustrations of a number of notable buildings and power plants which are equipped with their American steam jet ash conveyor, a method of ash removal which has come into marked favor among power plant engineers during the past four or five years. While only a few of their 1500 installations are shown, the high type of installations in which the conveyor is used, is indicative of the prestige and standing of the equipment. A number of letters of endorsement of the conveyor are included. Copies of the new booklet will be sent to any who are interested in the steam jet method of ash handling.

The Westinghouse Supply Catalogue generally regarded as an encyclopedia of things electrical is now being distributed. This issue for 1923-24 replaces and supercedes all catalogues issued heretofore on electrical supplies by the company. In appearance the new catalogue does not differ greatly from its predecessor. The former editions have proved so useful and satisfactory that no essential features were altered, the improvements being largely a matter of detail and refinement.

TRADE NOTES

What is considered the largest piping contract which has been let in recent years, has just been given by the Carnegie Steel Company to B. Floersheim & Company, Pittsburgh, Pa., for furnishing and erecting complete piping installations for their Clairton Works at Clairton, Pa. This contract includes furnishing and erecting of materials for Steam, Exhaust, Water, Air and Gas. The entire installation will be Crane Company materials throughout with exception of certain few specialties. The materials will range in sizes from the smallest up to and including 66 inch. Shipment of material will begin in from four to five weeks and construction work will be started within two to three months and will be completed within a year. B. Floersheim & Co. likewise are furnishing materials for the Koppers Company, who have the By-Product Coke Oven Plant Installation for this same company.

The Ohio Electric & Controller Company, Cleveland, Ohio, announce the resignation of Mr. Clarence J. Pagel, as District Sales Manager of Cleveland effective June 15th and the appointment of Mr. Harry A. Saunders as his successor.

The Louisville Gas & Electric Company is rebuilding its plant and will increase its manufacturing capacity to the extent of four additional 12 ft. carburetted water gas sets. The contract for furnishing and installing these sets has been awarded to the U. G. I. Contracting Company, of Philadelphia.

COMING MEETINGS

I. E. S. to Convene at Lake George, N. Y. The 1923 convention of the Illuminating Engineering Society is to be held Sept. 24 to 28 inclusive at Lake George, N. Y. The headquarters of the convention will be the Fort William Henry Hotel. A well balanced program of commercial and technical papers is being prepared by the committee on papers, under the direction of J. L. Stair of Chicago; a good program of entertainment will be provided, and unusual spectacular lighting features are planned.

Ohio Electric Light Association—Cedar Point, July 10-13. D. L. Gaskill, Greenville.

New England Division, N. E. L. A.—Swampscott, Mass., Sept. 6-8. Miss O. A. Bursiel, 149 Tremont St., Boston.

Michigan Electric Light Association—Grand Rapids, Sept. 11-13. Herbert Silvester, Detroit Edison Co., Ann Arbor.

Rocky Mountain Division, N. E. L. A.—Glenwood Springs, Col., Sept. 17-19. O. A. Weller, 900 15th St., Denver.

Illuminating Engineers Society—Lake George, N. Y., Sept. 24-28. S. G. Hibben, 29 West 39th St., New York.

Association of Iron and Steel Electrical Engineers—Buffalo, Sept. 24-28. J. F. Kelly, 513 Empire Bldg., Pittsburgh.

American Electro-chemical Society—Dayton, Ohio, Sept. 27-29. Colin G. Fink, Columbia University, New York.

NEWS OF THE PLANTS

The Texas Steel Company, Fort Worth, Tex., recently formed under Delaware laws with a capital of $5,000,000, has taken over the local plant of the Armstrong Steel & Iron Company, later known as George W. Armstrong, Inc. The new company will make extensive additions and improvements, including the installation of considerable new machinery and operating equipment. The present iron works will be converted into a steel mill for the production of steel bars, structural shapes, and kindred specialties. An order has been placed for a new electric steel furnace and it is expected to have the first unit of this plant ready for service during August. Rolling mills will be established and other plant units built to develop a capacity of about 5,000 tons of material a month. A steel casting department will also be operated, and the present oil well supply equipment branch of the business will be maintained. This latter department will be extended and improved, and increased in output. It is expected to give employment to about 200 operatives for the initial operations and to increase this quota to about 450 men as soon as machinery is installed. The new company is headed by John H. Kirby, well known oil operator of Houston, Tex. J. F. Foster is general manager.

The Commonwealth Steel Company, Pierce Building, St. Louis, Mo., will commence the erection of additions to its plant for increased production. Two new buildings will be erected, 100x400 ft. and 100x450 ft., respectively, with new power plant. The expansion is estimated to cost close to $100,000, including machinery.

The Eastern Steel Company, Pottsville, Pa., has work under way on a new addition to its structural steel and iron fabricating plant on Peacock Street, estimated to cost about $30,000. It will be one-story and equipped for general increase in production.

The Detroit Steel Products Company, Detroit, Mich., has commenced the construction of the first unit of its proposed new branch at Emeryville, near San Francisco, Cal., where a site of about 80,000 sq. ft. of land recently was acquired. The plant will be equipped for the manufacture of the different specialties of the company and is estimated to cost in excess of $80,000. Other units will be constructed in the near future. V. F. Dewey is president of the company, and E. R. Ailes, secretary and treasurer.

The Shenango Furnace Company, Pittsburgh, Pa., operating a blast furnace at Sharpsville, Pa., is arranging for the rebuilding of the portion of the subsidiary works recently destroyed by fire, with loss estimated at close to $35,000, including equipment.

The John L. Mullen Construction Company, Wabash Avenue, Pittsburgh, Pa., has recently acquired property on Banksville Avenue, about 200x300 ft., as a site for a new steel fabricating plant. Work will be commenced at an early date on the erection of a number of buildings, estimated to cost in excess of $70,000. The company is now operating a plant at Lawrenceville, near Pittsburgh, and it is proposed to continue this works in service. John L. Mullen is president of the company.

The Cleveland-Cliffs Iron Co., Cleveland, Ohio, has acquired a substantial interest in the Central Steel Company, Massillon, Ohio, and is perfecting plans for extensions and betterments at the works for considerable increase in production. The initial work will consist of a new blast furnace, for which plans will be drawn at an early date. Later, a by-products coke plant will be installed and other work laid out. To provide funds for the expansion the Central company has arranged for an increase in capital from 165,000 to 245,000 shares of stock, no par value. A total of 80,000 shares of stock will be offered at once at a price of $50 a share, the proceeds to be used in part for the construction of the new furnace. R. E. Bebb is chairman of the board.

The Cleveland Structural Steel Company, 6600 Park Avenue, Cleveland, Ohio, is perfecting plans for the erection of an addition to its plant for increase capacity in the fabricating department. The structure will be one story, 60x100 ft., and is estimated to cost close to $60,000, including equipment. A list of machinery to be installed will be prepared at an early date.

The Canisteo Iron Works, Inc., Hornell, N. Y., will commence the immediate erection of a new one-story building at its plant to replace the portion of the works recently destroyed by fire with loss estimated in excess of $25,000, including equipment. W. D. Carter is head.

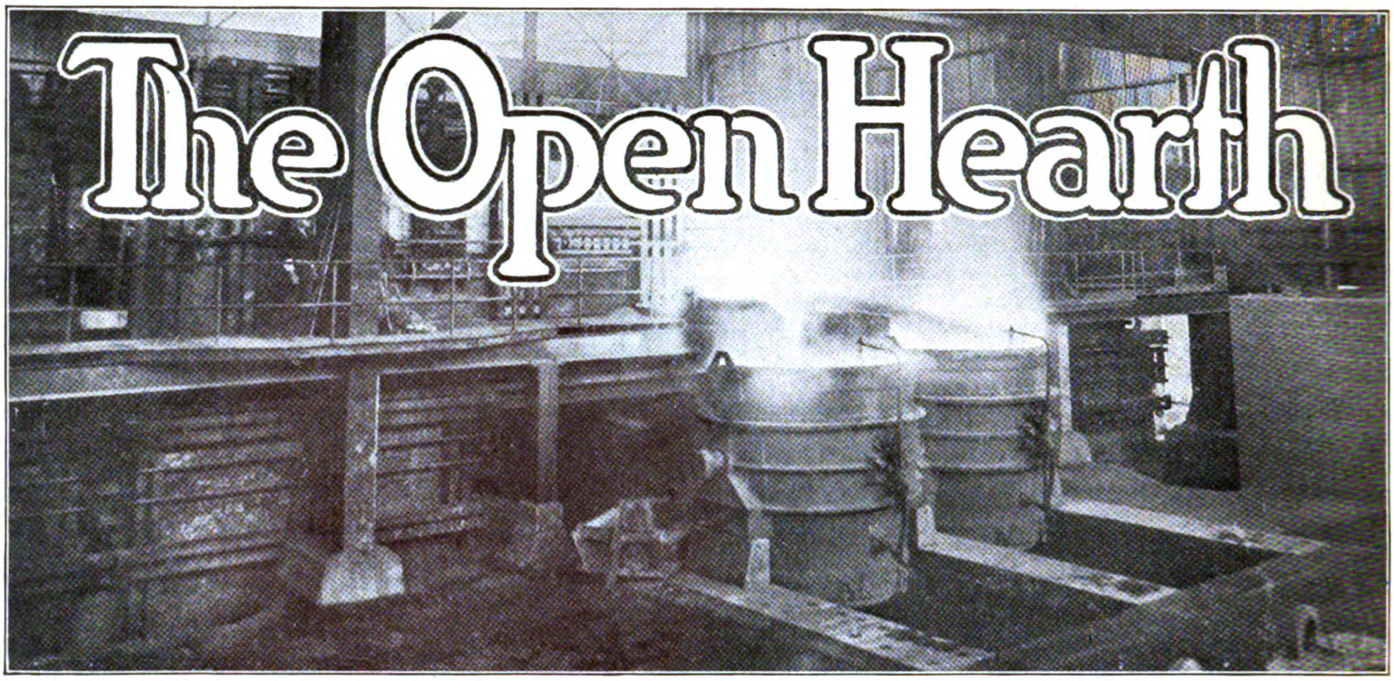
The Jones & Laughlin Steel Corporation, Pittsburgh, Pa., has tentative plans under advisement for its proposed new mill at Hammond, Ind., where a site totaling 440 acres of land has recently been secured. The works will consist of a number of buildings, including rolling mills, machine shop, power house, bar mill and other structures, estimated to cost close to $5,000,000, with equipment.

The Standard Steel & Bearings, Inc., Plainville, Conn., has completed plans and will commence the erection of two additions to its local plant, each to be one-story, 50x200 ft. and 60x160 ft., respectively. Equipment will be installed in the new mills for considerable increase in capacity. A portion of the machinery heretofore used at the works at Fiftieth Street and Lancaster Avenue, Philadelphia, Pa., will be used in the structures, the latter plant recently having been sold to the Pennsylvania Railroad Company. The extension at the Plainville plant will cost in excess of $75,000.

The McKinney Steel Company have placed contracts with Arthur G. McKee & Company, of Cleveland, for equipment which will be installed in connection with the rebuilding of Blast Furnaces Nos. 1 and 2 at their River Furnace Plant. These orders include a McKee Revolving Distributor for each of the above furnaces, with automatic electric control, as well as electric rigs for automatically operating the furnace bells. The McKee Company are also furnishing five Kling Patented Goggle Valves for controlling and by-passing the gas supply of the two furnaces.

The Consolidated Light, Heat & Power Company, Kenova, W. Va. has placed an order with the Westinghouse Electric Company for five complete sets of Underfeed stoker line shafting. This order is part of a general construction program brought about by power demands upon the American Railway Company.

The Niagara Falls Smelting & Refining Corporation, have commenced operations at Buffalo, N. Y., and are now in a position to make immediate shipments of all standard alloys in any quantity. A department exclusively for the manufacture of special alloys to customers specifications is maintained, in combination with a well equipped metallurgical research laboratory. Ernest G. Jarvis, well known metallurgical engineer, is vice president and general manager of the company.



The Open Hearth

F. F. Brodie has severed his connection with the Empire Machinery Exchange, Cleveland, and has organized a new company under the name of the United Machinery & Supply Company, to deal in new and second-hand machinery. The company has opened offices and store-room at 1609 St. Clair Avenue.

P. F. Freeman, formerly engineer of tests with the Pittsburgh Testing Laboratory, has opened offices for general consulting engineering at 311 Ross Street, Pittsburgh.

Captain Robert W. Hunt, head of Robert W. Hunt & Company, Chicago, the guest of honor at the annual meeting of the Western Society of Engineers at Chicago, June 19, was the recipient of the Washington award for the present year, for his pioneer work in the development of the steel industry and for a life devoted to the advancement of the engineering profession. The award is an inscribed tablet, one of which is presented annually to an American whose work has been of great benefit to the country. The award was founded by John W. Alvord in 1916. In 1922 it was given to Herbert Hoover, secretary of commerce. It is conferred by a commission representing the Western Society of Engineers, the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. Captain Hunt is a veteran of the civil war, is 86 years of age and still active. He began his work in rolling mills in 1856 and was the first to establish a chemical laboratory in a steel plant.

Gen. Otto H. Falk, president of the Allis-Chalmers Manufacturing Company, has returned to his home in Milwaukee after spending two months in Europe.

Charles M. Schwab, had conferred upon him the honor degree of Doctor of Laws by St. Francis college at Loretto, Pa., June 14. Mr. Schwab graduated from the college in 1881.

H. A. Schaupp of Johnstown, Pa., has been appointed assistant to W. W. Welsh, superintendent of the open-hearth department of the LaBelle works of the Wheeling Steel Corporation, Wheeling, W. Va., and has entered upon his duties.

William Whigham, vice president of the Carnegie Steel Company, Pittsburgh, has been elected a member of the executive committee of the citizens' committee on the city plan of Pittsburgh, it was announced recently. During the last year he served as chairman of the citizens' committee's sub-committee on waterways.

Stephen Moltrup of Beaver Falls, Pa., has retired as president of the Standard Gauge Steel Company, and Frederick N. Beegle, president of the Union Drawn Steel Company, of Beaver Falls, was elected to succeed Walter Moltrup as vice president, and Herbert May is the new treasurer. Stephen Moltrup was one of the founders of the Standard Gauge Company, and a member of the original board of directors. Mr. Moltrup is treasurer of the Moltrup Steel Products Company and will devote his entire time to that company.

H. C. Smith, former president of the Allith-Prouty Company, Danville, Ill., it is understood, will head the new company which is being formed to operate the foundry of the Moline Plow Company, at East Moline, Ill., which recently was acquired by the Chicago and Danville interests. Mr. Smith in addition to being a former president of the Allith-Prouty Company, also is a former president of the Danville Foundry Company. Other members of the company being organized are O. J. Failing, Frank Mancan, and E. M. Richardson, all formerly connected with the National Malleable Castings Company, Chicago, in executive capacities.

Charles G. Dubois, New York, president of the Western Electric Company, has been elected a trustee of Dartmouth college.

Perry E. Carhart, inspecting engineer, Illinois Steel Company, Chicago, and associated with that company since 1889, has asked to be retired on account of ill health. In appreciation of his long service, the company has appointed him to the position of consulting inspecting engineer without duties assigned at present. John Brunner, assistant inspecting engineer, has been promoted to manager of the department of metallurgy and inspection to succeed Mr. Carhart. R. G. Glass has been made assistant manager of the department to succeed Mr. Brunner.

Elmer Griffith has resigned as assistant superintendent of the New Philadelphia, Ohio, plant of the American Sheet & Tin Plate Company, to become superintendent of the new sheet mill of the Michigan Steel Corporation, which is being erected at Wyandotte, Mich.

George Gordon Crawford, president, Tennesee Company, accompanied by Mrs. Crawford, has sailed for Europe, intending to spend two to three months in France and Switzerland. Mr. Crawford stated before going that it is to be purely a recreational trip.

Frank N. Speller, metallurgist, National Tube Company, Pittsburgh, had conferred on him the degree of Doctor of Science by the University of Toronto, June 7.

Some Pointers on By-Product Coke Oven Operations

Dangers of and Treatment for Carbon Monoxide Poisoning

General Statement.

Carbon monoxide poisoning, as usually encountered, is an acute condition resulting from breathing atmospheres containing that gas.

Carbon monoxide is a colorless gas having no odor or taste in the concentrations usually encountered. It is slightly lighter than air (specific gravity 0.968), and readily diffuses in air to make a homogeneous mixture.

The chief reactions that promote the occurrence of carbon monoxide in the industries, and with which the problem of poisoning is actually associated in its formation, are (1) by the part oxidation of carbon or carbonaceous compounds, and (2) by the reduction of the previously formed, more stable, and comparatively harmless product of carbon and oxygen—namely, carbon dioxide.

Approximate percentage of carbon monoxide found in gases from various sources of poisoning.

	CO by volume Pct.
Blast-furnace stack gas	28.0
Bessemer furnace gas	25.0
Crucible furnace; gas fuel melting Al-Cu-Sn alloy	5.5
Cupola gas	17.0
Coke-oven gas	6.0
Coal gas	16.0
Carburetted water-gas	30.0
Blau gas	40.0
Producer gas from coke	25.0
Producer gas from oil	5.0
Fuel gas	30.0
Automobile exhaust gas (average of tests on 101 cars of all types)	7.0

Odor.

In the concentrations usually found, carbon monoxide cannot be detected by its odor.

Safety Lamp.

The use of a miner's flame safety lamp for the detection of carbon monoxide in air should not be tried, as it is difficult to detect with a safety lamp even the presence of 1.5 per cent of carbon monoxide. This percentage is exceedingly dangerous to life— in fact, a man breathing such an atmosphere would be overcome almost at once.

Detection by Tests on Small Animals.

Mice and birds[*] are more quickly affected than men by carbon monoxide, and may be used for detecting dangerous atmospheres.

Hoolamite detector.

The "hoolamite" or activated iodine pentoxide indicator for carbon monoxide[†] is frequently used by engineers of the Bureau of Mines engaged in mine rescue and recovery operations. The indicator gives immediate positive results with carbon monoxide in air in concentrations of 0.07 per cent or more.

Blood methods.

A qualitative detection of carbon monoxide in air in amounts greater than 0.03 to 0.04 per cent can be made by shaking a dilute solution of blood with the air[‡], and then comparing it to an unexposed sample of similarly diluted blood. If carbon monoxide is present, the exposed samples will be pinker than normal blood.

Chemical action of Carbon Monoxide.

Chemically, the recognized primary action of poisoning is in the union of the carbon monoxide gas with the hemoglobin of its normal function of combining with oxygen.

Effect of concentration of carbon monoxide.

With increasing concentration of carbon monoxide, the time required for a given amount of hemoglobin to combine with carbon monoxide would decrease very rapidly, until with 1.0 per cent it may require only time enough to take a few breaths to produce a saturation of 60 to 80 per cent, which is fatal.

Effect of respiratory exchange and exercise.

Roughly, the amount of carbon monoxide absorbed by the blood is directly proportional to the amount of air breathed,—that is, a man doing exercise will breathe approximately twice as much air as a man at rest and his blood will absorb carbon monoxide about twice as fast, while a man doing very strenuous work may breathe three or four times as much air as when at rest and his blood will absorb carbon monoxide in proportion to the increased respiratory exchange.

As carbon monoxide has no corrosive or irritating action on the tissues the physiological action of the poisoning is primarily one of anoxemia or oxygen-want.

After the removal of the carbon monoxide has been effected, there is no indicated destruction in the oxygen-carrying capacity of the hemoglobin, and it resumes its normal function of carrying oxygen to the tissues. Any effects that remain are due to secondary effects caused by the period of oxygen deprivation.

Pathology.

The color of the skin of persons poisoned by carbon monoxide differs from the color of persons dying from other causes. Many show rose-red spots on the face, neck, breast, and limbs, and others dark red or violet; but the non-appearance of such spots should not be taken as indicating the absence of carbon monoxide poisoning.

Symptoms.

The symptoms of carbon monoxide poisoning may be divided into two stages, depending on the action of the nervous system, the first being a stimulation, covering the period beginning with normal and ending in syncope, and the second a paralysis of the central nervous system beginning in syncope, extending through coma, and ending in apnea. The order of action in each, according to Crile, is the brain, spinal cord, and medulla.

Treatment—Preventive.

The chief factors in preventing carbon monoxide poisoning are: (1) Good ventilation, as this will dilute and carry away the gas; (2) avoidance as much as possible of any exposure to air known to contain carbon monoxide; (3) use of adequate protective equipment when atmospheres known to contain carbon monoxide are to be encountered; keeping calm when necessary to enter or be exposed unprotected to atmosphere containing the gas, not hurrying but getting to fresh air as quickly, and with as little exertion, as possible.

Emergency.

In the treatment of carbon monoxide poisoning the most important thing is to get that gas out of the blood as rapidly as possible.

It should be emphasized that an inhaler is much to be preferred, due to the fact that it is far more efficient than any improvised apparatus for the administration of these gases.

---

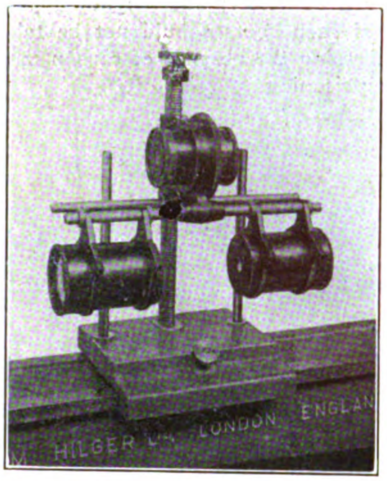
[*] Sayers, R. R., and Yant, W. P., The elimination of carbon monoxide from blood by treatment with air, with oxygen, and with a mixture of carbon dioxide and oxygen, Interior Department, Bureau of Mines, Unpublished report, 1923.

[†] Henderson, Yandell, and Haggard, H. W., The elimination of carbon monoxide from the blood after a dangerous degree of asphyxiation, and a therapy Pharm. and Exp. Therap., vol 16, 1920, pp. 11-20.

WITH THE EQUIPMENT MANUFACTURERS

Polarized Light Apparatus

Adam Hilger, Ltd., 75 Camden Road, London, Eng., announce the new apparatus shown in the accompanying cut. The apparatus was devised by Prof. E. G. Coker, F.R.S., and has been used by him for many years to determine the stress distribution in parts of machines and structures by observations on models constructed of transparent materials. By this means it is possible to measure, to an accuracy of plus or minus 2 per cent, the stress distribution under any system of loads, in any body which can be represented by a plate model stressed in its own plane. It is especially of use for cases in which no mathematical investigations are available. The experimental results obtained are immediately applicable to bodies constructed of metal and other engineering materials, numerous comparisons having shown that the measurements obtained with this apparatus on models cut from transparent celluloid represent very accurately the stresses in metals. Some parts of the apparatus, like the lateral extensometer and recording drum, have other uses, e. g., the direct measurement of stress distribution in materials generally, and the determination of Poisson's ratio and other physical constants.



In very many cases the facts of importance to an engineer can be ascertained at once by an inspection of the transparent model under load, and the places under greatest stress are in general indicated, as are also the places where failure first begins.

Usually the maximum stresses occur at the inner and outer edges of the material, and when these surfaces are not directly loaded the stresses at these places can be read off at once by aid of a comparator bar of the same material.

If it is necessary or desirable to make an investigation of the stress distribution, the standard equipment provides all that is necessary for a complete determination of the directions and magnitudes at every point of principal stresses.

The examination is carried out on models cut from transparent celluloid. Suitable sheets of selected celluloid are stocked, and the preparation of the models presents no difficulty. The apparatus is susceptible of various arrangements, of which the most important are as follows:

(a) The model is illuminated with circularly polarized light, and an image of it projected through a polarizing prism on to the screen. The mere inspection of the projected image generally reveals the places under greatest stress, and where failure will occur.

(b) Simultaneously with the image of the model as in (a) can be projected the image of a bar of the same thickness of celluloid, which is loaded by a measurable amount in the "Calibration Member." By varying the load till the color in the calibration bar matches that at any point along an unloaded edge of the model, the stress at that point can immediately be stated.

(c) The model can be illuminated by plane polarized light, and an image of it projected on the screen through an analyzer whose plane of polarization is perpendicular to that of the polarizer.

One can then see at once all points at which the principal stresses are either parallel to or at right angles to the plane of polarization, and by rotating both polarizer and analyzer simultaneously the directions of the principal stresses can thus be found at every point of the specimen. The difference P-Q between the principal stresses P and Q can be found by the color shown at the point in question, as compared with that on a standard bar in the Calibration Member (see (b) above).

In order to evaluate P and Q the extensometer can now be brought into play. This affords an extremely delicate means of measuring the difference of thickness due to loading, and by employing it first on a standard bar with known load one can calibrate it in such a manner that its indications give the value of P plus Q at any point. By measurement at a number of points the complete distribution of stress in a specimen can be found.

Automatic Coal Crusher and Sampler

Much money is wasted by having non-representative samples of coal analyzed. Unwarranted complaints are of ten based on analysis made from such samples, and sometimes unjust premiums are paid or penalties exacted, due to the samples not truly representing the coal from which they were taken.

The Sturtevant Mill Company of Boston, Mass., have recently placed on the market an automatic sampling machine which should prove of considerable value to both producers and consumers of coal. This will not only produce accurate samples, but will prove to be a big labor saver.

For automatically crushing coal and at the same time extracting a sample of 5, 10 or 15 in. of the amount passing through the machine. It does away with inaccurate hand methods and is used by many plants, purchasing fuel on a Btu. basis.

GEN. LIBRARY

JUL [illegible] 1923

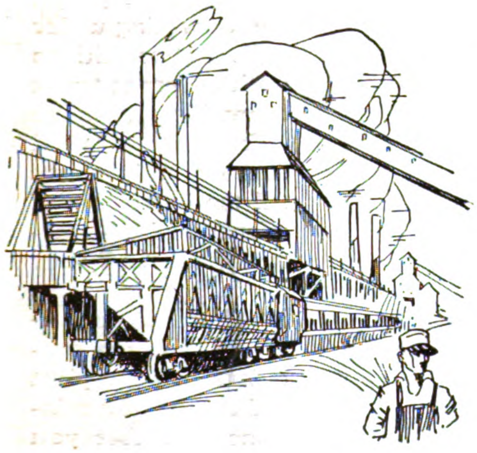
The Blast Furnace and Steel Plant

Member of the Audit Bureau of Circulations

PITTSBURGH, PA., JULY, 1923

Entered as second class mail matter at Pittsburgh, Pa., under the Act of Congress, March 3, 1879.

KOPPERS IMPROVED TYPE COMBINATION OVENS



NO STEEL COMPANY can say with certainty what its requirements of coke or gas will be during a span of fifteen years, which is generally accepted as the life of the brickwork in a by-product coke oven plant. Particularly the amount of coke oven gas that may be required.

New uses to which such gas may be put are constantly arising. Statistics show that the percentage of increase in the amount of coke oven gas required for steel plant operation far exceeds the increase in the amount of coke required.

In building a by-product coke plant this must be taken into consideration. Koppers combination coke and gas ovens, which can be heated with oven gas, producer gas, blast furnace gas or blue water gas are your insurance against such a contingency.

THE KOPPERS COMPANY

PITTSBURGH **CHICAGO**